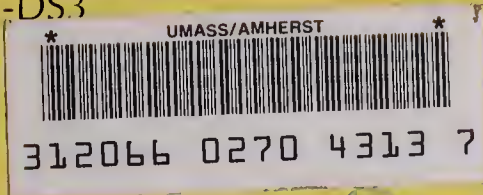


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EOEA #4325



CHARLES RIVER CROSSING

Draft

SUPPLEMENTAL

ENVIRONMENTAL IMPACT STATEMENT/REPORT

Appendices

- A: Transportation
- B: Air Quality
- C: 404(b)(1)
- D: Wetlands/Waterways
- E: Coastal Zone Management
Consistency Statement
- F: Permits
- G: Wind Impacts



Existing Charles River Crossing Area – Boston, Massachusetts



Federal Highway Administration
Massachusetts Highway Department



July 1993

FHWA-MA-EIS-82-02-DS3
EOEA #4325



CHARLES RIVER CROSSING

Draft

SUPPLEMENTAL

ENVIRONMENTAL IMPACT STATEMENT/REPORT

[v.2]

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Federal Highway Administration
Massachusetts Highway Department



July 1993



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Charles River Crossing

**CENTRAL ARTERY/TUNNEL PROJECT
BOSTON, MASSACHUSETTS**

SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT/REPORT

APPENDICES A THROUGH G

Prepared by

BECHTEL/PARSONS BRINCKERHOFF

for

THE MASSACHUSETTS HIGHWAY DEPARTMENT

in cooperation with

THE FEDERAL HIGHWAY ADMINISTRATION

July 1993

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Appendix A: Transportation

Appendix A

TRANSPORTATION

Appendix A, Transportation includes a set of tables showing traffic conditions data to supplement Section 4.1, Traffic and Transportation, in the DSEIS/R.

SUPPLEMENTARY TRAFFIC CONDITIONS DATA

Data are presented in this appendix to supplement the information on traffic conditions included in Section 4.1 of this DSEIS/R. Tables provide detailed forecasts for the year 2010 of traffic volumes and operating characteristics on expressway facilities and approach volumes at local and arterial roadway intersections.

Transportation Appendix Table 1

MAJOR EXPRESSWAY LINKS AWDT – YEAR 2010

Roadway Link/Ramp/HOV Lane	Link Volumes (AWDT)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non – River Tunnel
NORTHBOUND LINKS				
<u>Central Artery Between:</u>				
I-90 EB & WB ON and North St OFF Ramps	100,106	103,020	102,393	103,684
North St OFF and Essex St/Northern Ave ON Ramps	78,286	78,859	78,212	81,016
Essex/Northern ON and Cal Tunnel ON Ramps	106,744	n/a	n/a	n/a
Essex/Northern ON and Rte 1 NB SD/LC OFF Ramps	n/a	107,770	n/a	n/a
Essex/Northern ON and SD/LC OFF Ramps	n/a	n/a	107,170	110,197
Rte 1 NB SD/LC OFF and Sudbury ON Ramps	n/a	68,039	n/a	n/a
SD/LC OFF and C-L OFF to BHCC Ramps	n/a	n/a	85,802	89,062
<u>I-93 Mainline over Charles River Between:</u>				
Cal Tun ON and Rte 1 NB/CS/SD/LC OFF Ramps	118,959	n/a	n/a	n/a
Sudbury St ON and C-L OFF @ BHCC Ramps	n/a	87,660	n/a	n/a
C-L OFF to BHCC and Rte 1 NB OFF Ramps	n/a	n/a	71,532	73,599
Sudbury ON, from Sudbury to C-L OFF to BHCC Ramps	n/a	n/a	35,492	38,080
<u>I-93 Northbound Between:</u>				
Rte 1 NB/CS/SD/LC OFF and Rte 1 SB/CS ON Ramps	56,689	n/a	n/a	n/a
Rte 1 SB/CS ON and SD/LC ON Ramps	62,924	n/a	n/a	n/a
I-93 NB north of SD/LC ON Ramp (North Limits)	81,066	n/a	n/a	n/a
C-L OFF @ BHCC and Rte 1 SB/CS/SD/LC ON Ramps	n/a	63,122	n/a	n/a
I-93 NB N/of Rte 1 SB/CS/SD/LC ON Ramp (North Limits)	n/a	83,192	n/a	n/a
Rte 1 NB OFF and Sudbury ON Ramps	n/a	n/a	51,585	52,136
Sudbury ON and Rte 1 SB/CS/SD/LC ON Ramps	n/a	n/a	62,218	64,867
I-93 NB N/of Rte 1 SB/CS/SD/LC ON Ramp (North Limits)	n/a	n/a	83,995	83,992
I-93 NB HOV Component (after North Limits)	n/a	20,837	20,838	20,837
SOUTHBOUND LINKS				
<u>I-93 Southbound Between:</u>				
I-93 SB at North Project Limits	87,512	87,518	87,521	87,518
I-93 SB HOV Component at North Project Limits	n/a	14,988	14,988	14,986
HOV SB OFF and Rte 1 NB/CS/SD/LC OFF Ramps	n/a	60,103	60,076	60,108
Rte 1 NB/CS/SD/LC OFF and Rte 1 SB/CS ON Ramps	59,544	45,115	45,088	45,122
Rte 1 SB/CS ON and Mainline SB HOV ON Ramps	n/a	85,716	83,123	83,723
Rte 1 SB/CS ON and SD/LC ON Ramps	103,051	n/a	n/a	n/a
<u>I-93 Mainline over Charles River Between:</u>				
SD/LC ON and Cal Tun/Clinton OFF Ramps	120,501	n/a	n/a	n/a
Mainline SB HOV ON and SD/LC ON Ramps	n/a	100,703	98,110	98,710
<u>Central Artery Between:</u>				
SD/LC ON and Cal Tun/Clinton OFF Ramps	n/a	124,958	122,722	122,368
Cal Tun/Clinton OFF and New Chardon ON Ramps	97,319	97,739	96,204	95,722
New Chardon ON and Oliver St OFF Ramps	120,830	121,502	121,353	121,127

Note: SD is Storrow Drive; LC is Leverett Circle; CS is City Square

Transportation Appendix Table 2

CHARLES RIVER CROSSING SCREENLINES AWDT – YEAR 2010

Roadway Link/Ramp/HOV Lane	Approach Volumes (AWDT)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non – River Tunnel
NORTHBOUND LINKS				
<u>Express Facilities</u>				
I-93 Mainline	98,747	87,660	71,532	73,599
Double Crossing – CA-NB to SD-WB	20,212	n/a	n/a	n/a
Total: I-93 Mainline	118,959	87,660	71,532	73,599
Sudbury ON Ramp Over Charles River	n/a	n/a	35,492	38,080
<u>Storrow Connector</u>				
Storrow Connector to I-93N/Tobin	39,328	40,314	43,310	36,270
Double Crossing – SD-EB to CA-SB	17,451	n/a	n/a	n/a
CA-NB to Tobin (C-T Loop)	n/a	20,284	n/a	n/a
Total –	56,779	60,598	43,310	36,270
Total Express Facilities without Double Crossing –	138,075	148,258	150,334	147,949
Total Express Facilities with Double Crossing –	175,738	148,258	150,334	147,949
<u>Local Bridge Crossing</u>				
Charlestown Bridge	29,552	23,428	22,442	23,977
Charles River Dam	23,122	18,564	19,225	17,916
Longfellow Bridge	14,234	13,552	12,784	13,767
Harvard Bridge	21,946	22,567	22,365	22,466
Total –	88,854	78,111	76,816	78,126
Totals Northbound – Without Double Crossing –	226,929	226,369	227,150	226,075
Totals Northbound – Double Crossing –	37,663	n/a	n/a	n/a
Totals Northbound – With Double Crossing –	264,592	226,369	227,150	226,075
SOUTHBOUND LINKS				
<u>Express Facilities</u>				
I-93 Mainline	103,050	100,703	98,110	98,710
Double Crossing – SD-EB to CA-SB	20,212	n/a	n/a	n/a
Total: I-93 Mainline	123,262	100,703	98,110	98,710
<u>Storrow Connector</u>				
Storrow Connector to I-93N/Tobin	36,348	40,833	40,159	39,684
Double Crossing – CA-SB to SD-EB	17,451	n/a	n/a	n/a
Total –	53,799	40,833	40,159	39,684
Total Express Facilities without Double Crossing –	139,398	141,536	138,269	138,394
Total Express Facilities with Double Crossing –	177,061	141,536	138,269	138,394
<u>Local Bridge Crossings</u>				
Charlestown Bridge	29,150	28,084	30,915	30,558
Charles River Dam	22,085	20,641	20,708	20,993
Longfellow Bridge	17,999	17,100	17,316	17,097
Harvard Bridge	16,179	15,968	16,106	16,092
Total –	85,413	81,793	85,045	84,740
Totals Southbound – Without Double Crossing –	224,811	223,329	223,314	223,134
Totals Southbound – Double Crossings –	37,663	n/a	n/a	n/a
Totals Southbound – With Double Crossing –	262,474	223,329	223,314	223,134

Transportation Appendix Table 3

LEVERETT CIRCLE AWDT – YEAR 2010

Roadway Link/Ramp	Approach Volumes (AWDT)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non – River Tunnel
TRAFFIC ENTERING LEVERETT CIRCLE <i>(Individual Movements)</i>				
<u>Underpass Movements Under Leverett Circle</u>				
I-93/Tobin SB ramp to Storrow Drive WB	28,520	23,338	22,344	19,781
Central Artery NB ramp to Storrow Drive WB	12,056	21,990	23,161	23,741
Storrow Drive EB tunnel to I-93/Tobin NB	31,385	n/a	29,717	24,172
Storrow Drive EB tunnel to Central Artery SB	7,241	n/a	n/a	n/a
Subtotal –	79,202	45,328	75,222	67,694
<u>Surface Movements Towards Leverett Circle</u>				
I-93/Tobin SB to Leverett Circle	7,826	17,496	17,815	19,905
Central Artery NB to Leverett Circle	8,156	14,467	15,625	8,642
Storrow Drive EB to Leverett Circle	18,115	38,724	12,545	16,659
Charles Street EB to Leverett Circle	12,366	10,997	11,930	15,842
Charles River Dam SB to Leverett Circle	22,085	20,641	13,897	20,993
Nashua Street NB to Leverett Circle	20,038	14,107	20,708	14,839
Subtotal –	88,586	116,432	92,520	96,880
Total –	167,788	161,760	167,742	164,574
Lomasney ON Ramp	n/a	14,465	13,593	n/a
TRAFFIC EXITING LEVERETT CIRCLE <i>(Individual Movements)</i>				
<u>Underpass Movements Under Leverett Circle</u>				
I-93/Tobin SB ramp to Storrow Drive WB	28,520	23,338	22,344	19,781
Central Artery NB ramp to Storrow Drive WB	12,056	21,990	23,161	23,741
Storrow Drive EB tunnel to I-93/Tobin NB	31,385	n/a	29,717	24,172
Storrow Drive EB tunnel to Central Artery SB	7,241	n/a	n/a	n/a
Subtotal –	79,202	45,328	75,222	67,694
<u>Surface Movements away from Leverett Circle</u>				
Leverett Circle to I-93/Tobin NB	7,943	25,849	n/a	12,098
Leverett Circle to Central Artery SB	10,210	24,255	24,612	23,658
Leverett Circle to Storrow Drive WB	25,329	21,826	22,552	24,425
Leverett Circle to Charles River Dam NB	23,122	18,564	19,225	17,916
Leverett Circle to Nashua Street SB	8,760	12,980	13,584	7,592
Leverett Circle to Martha Way SB	13,222	12,958	12,547	11,191
Subtotal –	88,586	116,432	92,520	96,880
Total –	167,788	161,760	167,742	164,574
Lomasney ON Ramp	n/a	14,465	13,593	n/a

Transportation Appendix Table 3 (continued)

LEVERETT CIRCLE AWDT – YEAR 2010

Roadway Link/Ramp	Approach Volumes (AWDT)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel
LEVERETT CIRCLE APPROACHES				
Underpass & Surface				
<i>(Total Movements by Approach)</i>				
<u>Entering Approaches</u>				
Storrow Drive EB	56,741	38,724	42,262	40,831
Charles Street EB	12,366	10,997	11,930	15,842
Charles River Dam SB	22,085	20,641	13,897	20,993
Nashua Street NB	20,038	14,107	20,708	14,839
Southbound Ramp from I-93/Tobin	36,346	40,834	40,159	39,686
Northbound Ramp from Central Artery	20,212	36,457	38,786	32,383
Total –	167,788	161,760	167,742	164,574
<u>Exiting Approaches</u>				
Storrow Drive WB	65,905	67,154	68,057	67,947
Charles River Dam NB	23,122	18,564	19,225	17,916
Nashua Street SB	8,760	12,980	13,584	7,592
Northbound Ramp to I-93/Tobin	39,328	25,849	29,717	36,270
Southbound Ramp to Central Artery	17,451	24,255	24,612	23,658
Martha Way	13,222	12,958	12,547	11,191
Total –	167,788	161,760	167,742	164,574
Lomasney ON Ramp	n/a	14,465	13,593	n/a

Transportation Appendix Table 4
STORROW DRIVE AWDT – YEAR 2010

Roadway/Link/Ramp	Approach Volumes (AWDT)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel
EASTBOUND TRAFFIC				
<u>Back Bay Area:</u>				
Storrow West of Clarendon Street	64,309	64,313	64,315	64,313
Less (-) Clarendon Street OFF Ramp	6,553	6,197	6,340	6,733
Less (-) Arlington Street OFF Ramp	4,397	5,538	5,168	4,848
Plus (+) Berkeley Street ON Ramp	15,064	11,340	11,790	11,758
Plus (+) ON from Mt Vernon Street	10,793	7,463	7,615	7,555
Storrow East of Mt Vernon Street	79,216	71,381	72,212	72,045
Eastbound Entering Traffic	25,857	18,803	19,405	19,313
Eastbound Exiting Traffic	10,950	11,735	11,508	11,581
Storrow Through Traffic	53,359	52,578	52,807	52,732
<u>Charles Circle Area:</u>				
Storrow East of Mt Vernon Street	79,216	71,381	72,212	72,045
Plus (+) ON from Pickney Street	1,226	590	934	573
Less (-) OFF to Revere Street	4,961	6,414	6,218	6,217
Less (-) OFF to Charles Circle	18,741	26,832	24,665	25,570
Storrow under Longfellow	56,740	38,725	42,263	40,831
Plus (+) ON from Charles St EB	8,798	14,022	12,477	14,290
Total, East of Charles Circle (Storrow + Charles St)	65,538	52,747	54,740	55,121
<u>Fruit Street Area:</u>				
Charles St East of Charles Circle	8,798	14,022	12,477	14,290
Plus (+) ON from Fruit Street	1,927	778	1,275	1,379
Charles St East of Fruit Street	10,725	14,800	13,752	15,669
Storrow East of Fruit Street	56,740	38,725	42,263	40,831
Total, East of Fruit Street (Storrow + Charles St)	67,465	53,525	56,015	56,500
<u>Blossom Street Area:</u>				
Charles St East of Fruit Street	10,725	14,800	13,752	15,669
Less (-) OFF to Blossom Street	7,743	6,751	5,767	6,224
Plus (+) ON from Blossom Street	9,385	2,948	3,945	6,399
Charles St East of Blossom Street	12,367	10,997	11,930	15,844
Storrow East of Blossom Street	56,740	38,725	42,263	40,831
Total, East of Blossom Street (Storrow + Charles St)	69,107	49,722	54,193	56,675
<u>Entering Leverett Circle:</u>				
Charles Street to Leverett SURFACE	12,367	10,997	11,930	15,844
Storrow to Leverett SURFACE	18,114	38,725	12,546	16,659
Total to Leverett SURFACE	30,481	49,722	24,476	32,503
Storrow to Leverett UNDERPASS	38,626	n/a	29,717	24,172
Total to Leverett Circle Area (All Storrow + Charles St)	69,107	49,722	54,193	56,675

Transportation Appendix Table 4 (continued)

STORROW DRIVE AWDT – YEAR 2010

Roadway/Link/Ramp	Approach Volumes (AWDT)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel
WESTBOUND TRAFFIC				
<u>Departing Leverett Circle:</u>				
Charles Street Surface from Lev Cir	25,329	21,826	22,552	24,425
Leverett Tunnel WB to Storrow	40,576	45,328	45,506	43,521
Total West of Leverett Circle (Storrow + Charles St)	65,905	67,154	68,058	67,946
<u>Charles Circle Area:</u>				
Total West of Leverett Circle	65,905	67,154	68,058	67,946
Less (–) OFF to Charles Circle	12,638	11,192	11,904	12,471
Storrow under Longfellow	53,267	55,962	56,154	55,475
Plus (+) ON from Charles Circle	17,738	16,563	16,615	16,827
Total, Storrow West of Charles Circle	71,005	72,525	72,769	72,302
<u>Back Bay Ramps Area:</u>				
Storrow East of Arlington	71,005	72,525	72,769	72,302
Less (–) OFF to Arlington	18,624	19,563	19,726	19,443
Plus (+) ON from Berkeley	13,783	13,582	13,445	13,431
Total, Storrow West of Berkeley	66,164	66,544	66,488	66,290
Storrow Through Traffic	52,381	52,962	53,043	52,859

Transportation Appendix Table 5
CHARLES CIRCLE AWDT – YEAR 2010

Roadway/Link/Ramp	Approach Volumes (AWDT)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non – River Tunnel
ENTERING TRAFFIC				
<u>Entering Traffic On Charles Cir. Street Approaches</u>				
Storrow Drive Eastbound OFF Ramp	18,741	26,832	24,665	25,570
Storrow Drive Westbound OFF Ramp	12,638	11,192	11,904	12,471
Cambridge Street WB	21,684	20,276	19,862	20,406
Longfellow Bridge EB	17,999	17,100	17,316	17,097
Subtotal –	71,062	75,400	73,747	75,544
<u>Entering Traffic On Storrow Drive</u>				
Storrow Drive Eastbound, after EB OFF to Charles Cir.	56,741	38,724	42,263	40,831
Storrow Drive Westbound, after WB OFF to Charles Cir.	53,267	55,962	56,154	55,476
Subtotal –	110,008	94,686	98,417	96,307
Total –	181,070	170,086	172,164	171,851
EXITING TRAFFIC				
<u>Exiting Traffic From Charles Cir. Street Approaches</u>				
Charles Street Extension EB	8,798	14,022	12,477	14,290
Charles Street WB	9,121	9,639	10,362	9,762
Storrow Drive Westbound ON Ramp	17,738	16,563	16,615	16,827
Cambridge Street EB	21,168	21,624	21,511	20,900
Longfellow Bridge WB	14,234	13,552	12,784	13,767
Subtotal –	71,059	75,400	73,749	75,546
<u>Exiting Traffic On Storrow Drive</u>				
Storrow Drive Eastbound, after EB OFF to Charles Circle	56,741	38,724	42,263	40,831
Storrow Drive Westbound, after WB OFF to Charles Circle	53,267	55,962	56,154	55,476
Subtotal –	110,008	94,686	98,417	96,307
Total –	181,067	170,086	172,166	171,853

Transportation Appendix Table 6

INTERSECTION APPROACH AWDT – YEAR 2010

		Approach Volumes (AWDT)			
Name/Approach		Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel
DOWNTOWN/NORTH STA./BEACON HILL					
<u>Keany Square</u>					
Commercial	WB	15,282	14,944	14,772	14,589
Causeway	EB	11,104	9,132	9,093	9,895
N Washington	NB	15,421	12,488	12,209	12,395
Charlestown Bridge	SB	29,150	28,089	30,915	30,558
Totals –		70,957	64,653	66,989	67,437
<u>Causeway/Surface NB</u>					
Causeway	EB	11,003	8,980	8,937	9,705
Causeway	WB	12,262	12,354	13,206	15,440
Surface Artery	NB	12,162	9,744	9,447	8,593
Totals –		35,427	31,078	31,590	33,738
<u>Causeway/Surface SB</u>					
Causeway	EB	16,910	15,509	15,130	16,511
Causeway	WB	24,037	21,677	22,237	23,609
MBTA Garage Exit	SB	6,704	3,661	3,315	4,364
Totals –		47,651	40,847	40,682	44,484
<u>Causeway/Merrimac/Lomasney</u>					
Staniford	EB	13,791	20,108	18,917	15,163
Causeway	WB	14,171	11,863	12,108	10,521
Merrimac	NB	12,007	8,434	8,160	6,490
Lomasney	SB	19,833	20,139	19,969	20,364
Totals –		59,802	60,544	59,154	52,538
<u>Surface NB & SB/Valenti</u>					
N Washington	WB	26,458	26,237	27,296	23,210
Surface Artery	SB	12,660	11,582	11,498	15,833
Totals –		39,118	37,819	38,794	39,043
<u>Sumner Tunnel/N Washington</u>					
N Washington	NB	32,486	26,869	25,698	25,051
Sumner Tunnel	NB	7,185	7,246	6,931	6,565
Totals –		39,671	34,115	32,629	31,616
<u>New Chardon/Surface SB/Sumner</u>					
New Chardon	EB	16,909	15,028	15,268	15,608
Sumner Tunnel	NB	15,960	10,964	10,926	11,415
Surface Artery	SB	39,071	37,772	38,747	38,997
Totals –		71,940	63,764	64,941	66,020
<u>New Sudbury/Surface Sb</u>					
New Sudbury	EB	13,495	16,290	16,451	16,687
Surface Artery	SB	3,952	4,272	3,917	4,422
Totals –		17,447	20,562	20,368	21,109
<u>New Sudbury/Cross/Sudbury On</u>					
New Sudbury	EB	4,619	10,099	10,328	11,602
Cross	NB	24,278	29,255	29,013	28,433
Totals –		28,897	39,354	39,341	40,035

Transportation Appendix Table 6 (continued)

INTERSECTION APPROACH AWDT – YEAR 2010

		Peak Hour Approach Volumes (vph)			
Name/Approach		Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel
DOWNTOWN/NORTH STA./BEACON HILL					
<u>New Chardon/Congress</u>					
New Chardon	WB	26,117	21,874	22,116	22,742
Congress	NB	29,393	27,612	27,390	26,646
Merrimac	SB	9,252	8,403	8,378	9,188
Totals –		64,762	57,889	57,884	58,576
<u>New Sudbury/Congress</u>					
New Sudbury	EB	22,556	23,279	22,851	23,546
Congress	NB	18,110	19,320	19,933	18,467
Congress	SB	13,491	14,664	15,118	16,023
Totals –		54,157	57,263	57,902	58,036
<u>State/Congress</u>					
State	WB	16,732	16,803	16,540	16,352
Congress	NB	13,547	14,575	14,341	14,135
Congress	SB	16,455	16,379	16,267	16,222
Totals –		46,734	47,757	47,148	46,709
<u>State/Surface SB</u>					
State	WB	6,361	5,706	5,644	5,598
Surface Artery	SB	34,421	34,369	34,166	34,356
Totals –		40,782	40,075	39,810	39,954
<u>State/Surface NB</u>					
State	WB	8,795	8,795	8,795	8,795
Surface Artery	NB	18,872	20,122	20,005	19,750
Totals –		27,667	28,917	28,800	28,545
<u>Lomasney/Nashua</u>					
Martha Way	EB	9,006	8,731	8,202	7,043
Lomasney	NB	18,836	22,537	21,194	12,168
Nashua	SB	10,166	13,466	14,089	13,794
Land Use Zones	na	16,490	19,425	19,772	18,724
Totals –		54,498	64,159	63,257	51,729
CHARLESTOWN					
<u>City Square</u>					
I-93 C-L Exit	EB	22,203	0	0	0
Chelsea	WB	23,273	22,094	22,016	22,297
Charlestown Br	NB	29,552	23,428	22,442	23,977
Rutherford	SB	36,848	38,794	39,220	40,062
Totals –		111,876	84,316	83,678	86,336
<u>Rutherford/I-93 Connector</u>					
Connector	EB	7,111	7,878	8,100	8,508
Rutherford	NB	34,827	17,550	16,618	18,193
Rutherford	SB	43,557	44,606	44,501	45,875
Totals –		85,495	70,034	69,219	72,576

Transportation Appendix Table 6 (continued)

INTERSECTION APPROACH AWDT – YEAR 2010

		Peak Hour Approach Volumes (vph)			
Name/Approach		Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel
CHARLESTOWN					
<u>Rutherford/Gilmore – Surface</u>					
Gilmore	EB	21,080	17,526	16,967	17,085
Austin	WB	7,842	5,630	5,518	5,170
Rutherford	NB	14,712	10,608	10,885	11,309
Rutherford	SB	9,670	12,926	12,571	11,952
Subtotal –		53,304	46,690	45,941	45,516
<u>Rutherford/Gilmore – Underpass</u>					
Rutherford	NB	22,891	7,404	7,079	6,909
Rutherford	SB	29,195	31,570	31,826	32,722
Subtotal –		52,086	38,974	38,905	39,631
Totals –		105,390	85,664	84,846	85,147
<u>I-93/U.S. 1/Connector</u>					
Connector	EB	N.A.	N.A.	N.A.	N.A.
Connector	WB	N.A.	13,862	12,699	14,933
Ramp to/from U.S 1	NB	N.A.	9,920	9,701	10,166
Ramp to/from I-93	SB	N.A.	9,915	9,917	9,946
Totals –			33,697	32,317	35,045
<u>Rutherford/C-L @ Bunker Hill Comm. College</u>					
C-L OFF @ BHCC	EB	0	24,538	24,859	25,349
Rutherford	NB	22,891	12,522	12,308	12,073
Rutherford	SB	40,154	40,260	41,158	40,945
Totals –		63,045	77,320	78,325	78,367
BEACON HILL					
<u>Cambridge/Sudbury</u>					
Cambridge	EB	29,766	28,828	28,619	28,543
Cambridge	WB	11,602	11,676	11,536	11,128
Somerset	SB	5,644	6,061	5,988	5,957
Totals –		47,012	46,565	46,143	45,628
<u>Cambridge/Chardon</u>					
Cambridge	EB	22,271	21,351	21,149	21,273
Cambridge	WB	9,077	8,351	8,552	7,512
Bowdoin	NB	10,813	11,368	11,358	11,219
Chardon	SB	20,664	17,561	17,455	17,748
Totals –		62,825	58,631	58,514	57,752
<u>Cambridge/Stamford</u>					
Cambridge	EB	20,606	21,302	21,045	20,580
Cambridge	WB	24,819	21,889	22,050	21,150
Stamford	SB	10,122	9,832	9,461	9,788
Totals –		55,547	53,023	52,556	51,518
<u>Cambridge/Blossom/Garden</u>					
Cambridge	EB	15,713	16,090	15,024	14,860
Cambridge	WB	19,450	15,539	15,056	16,253
Garden	NB	3,357	4,233	4,589	4,383
Blossom	SB	5,926	6,024	5,658	5,607
Totals –		44,446	41,886	40,327	41,103
<u>Cambridge/Grove</u>					
Cambridge	EB	18,611	19,643	18,941	18,635
Cambridge	WB	21,354	19,657	18,880	19,764
N. Grove	SB	797	810	770	783
Totals –		40,762	40,110	38,591	39,182

Transportation Appendix Table 6 (continued)

INTERSECTION APPROACH AWDT – YEAR 2010

			Peak Hour Approach Volumes (vph)			
Name/Approach			Scheme "Z"	8.1D Mod 5	River Tunnel	Non – River Tunnel
CITY OF CAMBRIDGE						
<u>O'Brien/Gilmore</u>						
O'Brien	SB		20,508	20,809	21,065	20,906
Charles River Dam	NB		23,122	18,564	19,225	17,916
Gilmore Bridge	WB		19,663	20,585	20,098	20,056
Edwin Land Blvd.	EB		18,051	16,504	16,447	16,711
Totals –			81,344	76,462	76,835	75,589
<u>Lechmere Square</u>						
O'Brien	SB		11,707	12,016	11,827	12,203
O'Brien	NB		20,330	19,682	20,316	19,855
Cambridge	EB		17,545	17,957	18,147	18,563
Totals –			49,582	49,655	50,290	50,621
<u>Cambridge/First</u>						
Cambridge	EB		6,628	6,667	6,695	6,659
Cambridge	WB		10,447	10,500	10,613	11,001
First	NB		8,284	8,837	8,479	9,108
Totals –			25,359	26,004	25,787	26,768
<u>O'Brien/Third</u>						
O'Brien	EB		21,549	21,647	21,724	21,703
O'Brien	WB		18,631	18,346	18,614	18,715
Third	NB		6,556	6,404	6,339	6,766
Totals –			46,736	46,397	46,677	47,184
<u>Cambridge/Third</u>						
Cambridge	EB		2,944	2,852	2,839	3,047
Cambridge	WB		4,075	4,177	3,926	4,138
Third	NB		4,376	4,484	4,313	4,593
Third	SB		4,100	3,924	4,207	4,127
Totals –			15495	15437	15285	15905
<u>Third/Binney</u>						
Binney	EB		10,756	10,520	10,749	11,452
Binney	WB		3,852	4,128	4,154	3,663
Third	NB		5,225	5,935	5,517	5,805
Third	SB		4,927	4,873	5,205	4,883
Totals –			24,760	25,456	25,625	25,803
<u>Third/Broadway</u>						
Broadway	EB		5,864	5,881	5,649	5,961
Broadway	WB		13,428	13,439	13,222	13,554
Third	SB		3,133	3,572	3,547	3,333
Totals –			22,425	22,892	22,418	22,848
<u>Lafayette Square</u>						
Mass Ave	EB		22,622	22,622	22,622	22,622
Mass Ave	WB		7,793	7,793	7,793	7,793
Main Street	WB		7,903	7,903	7,903	7,903
Columbia	SB		6,252	6,252	6,252	6,252
Totals –			44,570	44,570	44,570	44,570
<u>Memorial Drive/Mass Ave</u>						
SURFACE VOLUMES						
Memorial Drive	EB		2,191	1,878	1,996	2,352
Memorial Drive	WB		1,876	1,680	1,326	1,660
Mass Avenue	NB		21,946	22,567	22,365	22,466
Mass Avenue	SB		14,504	14,457	14,627	14,200
Subtotal –			40,517	40,582	40,314	40,678
UNDERPASS VOLUMES						
Memorial Drive	EB		18,094	17,667	17,668	17,535
Memorial Drive	WB		15,525	15,776	16,527	17,638
Subtotal –			33,619	33,443	34,195	35,173
Totals –			74,136	74,025	74,509	75,851

Transportation Appendix Table 7

**COMPARISON OF AGGREGATE TRAVEL STATISTICS FOR MAJOR FREEWAY SECTIONS
YEAR 2010**

Section/Alternative	AM Peak			PM Peak		
	Average Speed (mph)	Total Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	Total Distance (miles)	Total Travel Time (minutes)
Northbound:						
Scheme "Z"	39	2.2	3.36	21	2.2	6.35
8.1D Mod 5	33	2.2	3.89	27	2.2	4.76
River Tunnel	36	2.2	3.58	25	2.2	5.18
Non-River Tunnel	36	2.2	3.67	26	2.2	5.09
Southbound:						
Scheme "Z"	26	2.2	5.11	36	2.2	3.63
8.1D Mod 5	20	2.2	6.65	21	2.2	6.32
River Tunnel	19	2.2	6.95	34	2.2	3.90
Non-River Tunnel	19	2.2	6.97	30	2.2	4.38
Eastbound:						
Scheme "Z"	32	2.9	5.42	21	2.9	8.19
8.1D Mod 5	31	2.6	5.02	22	2.6	6.89
River Tunnel	43	2.0	2.77	23	2.0	5.09
Non-River Tunnel	35	2.9	4.99	26	2.9	6.74
Westbound:						
Scheme "Z"	27	3.0	6.53	30	3.0	5.97
8.1D Mod 5	21	2.9	8.19	25	2.9	6.93
River Tunnel	13	2.9	13.15	16	2.9	10.70
Non-River Tunnel	13	2.9	13.06	16	2.9	10.74

Northbound = (Mainline NB from Essex/Northern On-Ramp to Sullivan Square)
 Southbound = (Mainline SB from Sullivan Square to Sudbury On-Ramp)
 Eastbound = (Storrow Drive EB from Blossom Street to Tobin Bridge at End of CANA Tunnel)
 Westbound = (Tobin Bridge WB from Start of CANA Tunnel to Storrow Drive at Blossom Street)

Transportation Appendix Table 8

AM PEAK HOUR MAINLINE TRAFFIC OPERATIONS – YEAR 2010

	VOLUME (vph)				LINK SPEED (mph)				LINK LOS (as determined by link speed and traffic flow density)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel
CENTRAL ARTERY – I-93 MAINLINE Roadway Link/Ramp/HOV Lane												
NORTHBOUND LINKS												
Central Artery Between:												
Essex/Northern ON and Callahan Tunnel ON Ramps	6,894	n/a	n/a	n/a	40	n/a	n/a	n/a	E	n/a	n/a	n/a
Essex/Northern ON and Rte 1 NB SD/LC OFF Ramps	n/a	6,772	n/a	n/a	n/a	25	n/a	n/a	n/a	F	n/a	n/a
Essex/Northern ON and SD/LC OFF Ramps	n/a	n/a	6,819	6,914	n/a	n/a	24	23	n/a	n/a	F	F
Rte 1 NB SD/LC OFF and Sudbury ON Ramps	n/a	4,035	n/a	n/a	n/a	41	n/a	n/a	n/a	C	n/a	n/a
SD/LC OFF and C-L OFF to BHCC Ramps	n/a	n/a	4,752	4,789	n/a	n/a	35	35	n/a	n/a	D	D
I-93 Mainline over Charles River Between:												
Callahan Tunnel ON and Rte 1 NB/CS/SD/LC OFF Ramps	7,734	n/a	n/a	n/a	34	n/a	n/a	n/a	E	n/a	n/a	n/a
Sudbury St ON and C-L OFF @ BHCC Ramps	n/a	5,078	n/a	n/a	n/a	41	n/a	n/a	n/a	E	n/a	n/a
C-L OFF to BHCC and Rte 1 NB OFF Ramps	n/a	n/a	3,592	3,683	n/a	n/a	45	45	n/a	n/a	C	C
Sudbury ON, from Sudbury to C-L OFF to BHCC Ramps	n/a	n/a	2,212	2,247	n/a	n/a	35	35	n/a	n/a	D	D
I-93 Northbound Between:												
Rte 1 NB/CS/SD/LC OFF and Rte 1 SB/CS ON Ramps	3,023	n/a	n/a	n/a	47	n/a	n/a	n/a	C	n/a	n/a	n/a
Rte 1 SB/CS ON and SD/LC ON Ramps	3,321	n/a	n/a	n/a	47	n/a	n/a	n/a	C	n/a	n/a	n/a
I-93 NB N/of SD/LC ON Ramp (North Limits)	4,288	n/a	n/a	n/a	47	n/a	n/a	n/a	C	n/a	n/a	n/a
C-L OFF @ BHCC and Rte 1 SB/CS/SD/LC ON Ramps	n/a	3,373	n/a	n/a	n/a	47	n/a	n/a	n/a	C	n/a	n/a
Rte 1 NB OFF and Sudbury ON Ramps	n/a	n/a	2,834	2,872	n/a	n/a	45	45	n/a	n/a	C	C
Sudbury ON and Rte 1 SB/CS/SD/LC ON Ramps	n/a	n/a	3,256	3,371	n/a	n/a	45	45	n/a	n/a	C	C
I-93 NB N/of Rte 1 SB/CS/SD/LC ON Ramp (North Limits)	n/a	4,402	4,402	4,402	n/a	n/a	45	45	n/a	n/a	C	C
I-93 NB HOV Component (after North Limits)	n/a	812	812	812	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
I-93 Northbound Viaducts over Charles River:												
Ramp from Storrow/Leverett to Tobin/I-93 NB	n/a	n/a	n/a	1,671	n/a	n/a	n/a	30	n/a	n/a	n/a	C
Ramp from Sumner/Sudbury/I-93 NB to BHCC/I-93 NB	n/a	n/a	2,212	2,247	n/a	n/a	27	45	n/a	n/a	E	C

Note: SD is Storrow Drive; LC is Leverett Circle; CS is City Square

Transportation Appendix Table 8 (continued)
AM PEAK HOUR MAINLINE TRAFFIC OPERATIONS – YEAR 2010

	VOLUME (vph)				LINK SPEED (mph)				LINK LOS (as determined by link speed and traffic flow density)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel	Scheme "Z"	8.1D Mod 5	River Tunnel	Non- River Tunnel
CENTRAL ARTERY – I-93 MAINLINE Roadway Link/Ramp/HOV Lane SOUTHBOUND LINKS												
	I-93 Southbound Between:											
	I-93 SB at North Project Limits											
	I-93 SB HOV Component at North Project Limits											
	HOV SB OFF and Rte 1 NB/CS/SD/LC OFF Ramps											
	Rte 1 NB/CS/SD/LC OFF and Rte 1 SB/CS ON Ramps											
	Rte 1 SB/CS ON and Mainline SB HOV ON Ramps											
	Rte 1 SB/CS ON and SD/LC ON Ramps											
	I-93 Mainline over Charles River Between:											
	SD/LC ON and Callahan Tunnel/Clinton OFF Ramps											
Mainline SB HOV ON and SD/LC ON Ramps												
Central Artery Between:												
	SD/LC ON and Callahan Tunnel/Clinton OFF Ramps											
	Cal Tun/Clinton OFF and New Chardon ON Ramps											
	New Chardon ON and Oliver St OFF Ramps											
I-93 Southbound Viaduct over Charles River:												
Ramp from I-93 SB to Storrow/Leverett												
STORROW DRIVE EASTBOUND												
	Storrow Drive Between:											
	Blossom St. and River Tunnel Ramp											
	Blossom St. and Ramp to I-93 NB											
	Blossom St. and Leverett Circle											

Note: SD is Storrow Drive; LC is Leverett Circle; CS is City Square

Transportation Appendix Table 9

PM PEAK HOUR MAINLINE TRAFFIC OPERATIONS – YEAR 2010

	VOLUME (vph)				LINK SPEED (mph)				LINK LOS (as determined by link speed and traffic flow density)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non – River Tunnel	Scheme "Z"	8.1D Mod 5	River Tunnel	Non – River Tunnel	Scheme "Z"	8.1D Mod 5	River Tunnel	Non – River Tunnel
CENTRAL ARTERY – I-93 MAINLINE Roadway Link/Ramp/HOV Lane												
NORTHBOUND LINKS												
Central Artery Between:												
Essex/Northern ON and Callahan Tunnel ON Ramps	7,975	n/a	n/a	n/a	12	n/a	n/a	n/a	F	n/a	n/a	n/a
Essex/Northern ON and Rte 1 NB SD/LC OFF Ramps	n/a	7,968	n/a	n/a	n/a	14	n/a	n/a	n/a	F	n/a	n/a
Essex/Northern ON and SD/LC OFF Ramps	n/a	n/a	7,961	8,179	n/a	n/a	15	14	n/a	n/a	F	F
Rte 1 NB SD/LC OFF and Sudbury ON Ramps	n/a	5,228	n/a	n/a	n/a	35	n/a	n/a	n/a	E	n/a	n/a
SD/LC OFF and C-L OFF to BHCC Ramps	n/a	n/a	6,654	7,077	n/a	n/a	23	21	n/a	n/a	F	F
I-93 Mainline over Charles River Between:												
Callahan Tunnel ON and Rte 1 NB/CS/SD/LC OFF Ramps	8,831	n/a	n/a	n/a	12	n/a	n/a	n/a	F	n/a	n/a	n/a
Sudbury St ON and C-L OFF @ BHCC Ramps	n/a	6,800	n/a	n/a	n/a	35	n/a	n/a	n/a	F	n/a	n/a
C-L OFF to BHCC and Rte 1 NB OFF Ramps	n/a	n/a	5,495	5,740	n/a	n/a	35	35	n/a	n/a	E	E
Sudbury ON, from Sudbury to C-L OFF to BHCC Ramps	n/a	n/a	2,923	3,233	n/a	n/a	29	23	n/a	n/a	F	F
I-93 Northbound Between:												
Rte 1 NB/CS/SD/LC OFF and Rte 1 SB/CS ON Ramps	4,369	n/a	n/a	n/a	40	n/a	n/a	n/a	D	n/a	n/a	n/a
Rte 1 SB/CS ON and SD/LC ON Ramps	4,842	n/a	n/a	n/a	43	n/a	n/a	n/a	D	n/a	n/a	n/a
I-93 NB N/of SD/LC ON Ramp (North Limits)	6,399	n/a	n/a	n/a	45	n/a	n/a	n/a	D	n/a	n/a	n/a
C-L OFF @ BHCC and Rte 1 SB/CS/SD/LC ON Ramps	n/a	4,813	n/a	n/a	n/a	46	n/a	n/a	n/a	C	n/a	n/a
Rte 1 NB OFF and Sudbury ON Ramps	n/a	n/a	3,854	3,971	n/a	n/a	42	40	n/a	n/a	D	D
Sudbury ON and Rte 1 SB/CS/SD/LC ON Ramps	n/a	n/a	4,896	5,153	n/a	n/a	46	42	n/a	n/a	E	E
I-93 NB N/of Rte 1 SB/CS/SD/LC ON Ramp (North Limits)	n/a	6,599	6,649	6,649	n/a	n/a	50	50	n/a	n/a	D	D
I-93 NB HOV Component (after North Limits)	n/a	1,476	1,526	1,526								
I-93 Northbound Viaducts over Charles River:												
Ramp from Storrow/Leverett to Tobin/I-93 NB	n/a	n/a	n/a	2,870	n/a	n/a	n/a	21	n/a	n/a	n/a	F
Ramp from Sumner/Sudbury/I-93 NB to BHCC/I-93 NB	n/a	n/a	2,923	3,233	n/a	n/a	29	23	n/a	n/a	E	F

Note: SD is Storrow Drive; LC is Leverett Circle; CS is City Square

Transportation Appendix Table 9 (continued)

PM PEAK HOUR MAINLINE TRAFFIC OPERATIONS – YEAR 2010

	VOLUME (vph)				LINK SPEED (mph)				LINK LOS (as determined by link speed and traffic flow density)			
	Scheme "Z"	8.1D Mod 5	River Tunnel	Non-River Tunnel	Scheme "Z"	8.1D Mod 5	River Tunnel	Non-River Tunnel	Scheme "Z"	8.1D Mod 5	River Tunnel	Non-River Tunnel
CENTRAL ARTERY – I-93 MAINLINE Roadway Link/Ramp/HOV Lane												
	SOUTHBOUND LINKS											
	I-93 Southbound Between:											
	I-93 SB at North Project Limits											
	I-93 SB HOV Component at North Project Limits											
	HOV SB OFF and Rte 1 NB/CS/SD/LC OFF Ramps											
	Rte 1 NB/CS/SD/LC OFF and Rte 1 SB/CS ON Ramps											
	Rte 1 SB/CS ON and Mainline SB HOV ON Ramps											
	Rte 1 SB/CS ON and SD/LC ON Ramps											
I-93 Mainline over Charles River Between:	8,324	n/a	n/a	n/a	35	n/a	n/a	n/a	E	n/a	n/a	n/a
	n/a	6,759	6,626	6,667	n/a	35	32	31	n/a	E	E	E
Central Artery Between:	n/a	8,639	8,599	8,545	n/a	32	32	30	n/a	E	E	E
	6,788	6,682	6,670	6,625	30	35	35	35	E	E	E	E
	8,170	8,144	8,210	8,167	30	33	33	33	E	E	E	E
I-93 Southbound Viaduct over Charles River:	Ramp from I-93 SB to Storrow/Leverett											
	n/a	2,851	2,822	2,818	n/a	27	27	27	n/a	E	E	E
STORROW DRIVE EASTBOUND												
Storrow Drive Between:												
	Blossom St. and River Tunnel Ramp											
	Blossom St. and Ramp to I-93 NB											
	Blossom St. and Leverett Circle											

Note: SD is Storrow Drive; LC is Leverett Circle; CS is City Square

Transportation Appendix Table 10

INVENTORY OF EXISTING PARKING SUPPLY IN THE ARTERY CORRIDOR

Parcel		Capacity (no. of Spaces)	Scheme "Z"		8.1D Mod 5		River Tunnel		Non-River Tunnel	
No.	Name		Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.
1	MDC: Leverett Circle Lot	102	n/a	n/a	n/a	28	n/a	102	n/a	n/a
2	MDC: Charles River Dam Lot	105	30	6	30	22	30	22	30	22
3	Charles River Buildings	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	Stop & Shop	40	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	Anelex (back)	582	290	292	335	247	335	247	335	247
6	MGH: Nashua Street Lot	632	n/a	143	n/a	632	n/a	261	n/a	214
7	Registry of Motor Vehicles (side)	27	n/a	27	27	n/a	27	n/a	27	n/a
8	Registry of Motor Vehicles (back)	23	n/a	23	23	n/a	23	n/a	23	n/a
9	Lomansey Way	72	72	n/a	72	n/a	72	n/a	72	n/a
10	Martha Road	78	78	n/a	78	n/a	78	n/a	78	n/a
11	MHD: Nashua Street Lot (Helopad)	88	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
12	MWRA: Water Treatment Plant	34	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13	Guilford: B&M Yards	31	31	n/a	31	n/a	31	n/a	31	n/a
14	Spaulding Hospital	94	n/a	n/a	n/a	64	n/a	64	n/a	64
15	Suffolk County Jail	18	n/a	n/a	n/a	18	n/a	n/a	n/a	n/a
16	Nashua Street	23	n/a	n/a	n/a	7	n/a	3	n/a	3
17	Beverly Street	33	33	n/a	33	n/a	33	n/a	33	n/a
18	Bunker Hill Community College Lot	650	n/a	n/a	58	80	58	25	58	25
Total –		2732	534	491	687	1098	687	724	687	575

Appendix B: Air Quality

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Appendix B

AIR QUALITY

1 INTRODUCTION

The Federal Highway Administration (FHWA), in its Record of Decision on the Final Supplemental Environmental Impact Statement (FSEIS/R) of the Central Artery/Tunnel (CA/T) Project, (May 10, 1991) agreed to remain open throughout the project development process to take advantage of new information which may reduce environmental impacts. The purpose and need for additional action in the Area North of Causeway Street have been discussed in detail in Chapter 1 of this Draft Supplemental Environmental Impact Statement/Report (DSEIS/R) for the Charles River Crossing.

As part of the DSEIS/R, the Massachusetts and National Environmental Policy Acts (MEPA and NEPA) required that an air quality analysis be performed to assess the potential environmental effects due to the changes of motor vehicle emissions resulting from the proposed project change. This appendix describes the methodology and analyses performed to meet the requirements of the 1990 Clean Air Act Amendments (CAAA) (58 FR 3766), the Massachusetts State Implementation Plan (MSIP), and the Massachusetts Certification Process for Roadway Tunnel Ventilation Systems in the Metropolitan Boston Air Pollution Control District (310 CMR 7.38).

Three project design alternatives were analyzed in this DSEIS/R. Air quality effects associated with each alternative were compared to the approved Proposed Action (referred to as "Scheme Z ") as disclosed in the 1991 FSEIS/R. The Scheme Z river crossing is treated in these analyses as an equivalent of the future "no-build" option, since this approved alternative is already under construction.

Due to the changes in EPA forecasting emission models, and new mandated Federal and State regulations regarding motor vehicle emission controls for future years, the forecast for the proposed action (Scheme Z) has been re-analyzed in order to permit a direct comparison with the three proposed alternatives.

Included in this appendix is a description of existing air quality monitored levels, an analysis of the effects on regional emission levels (mesoscale analysis) of carbon monoxide (CO), volatile organic compounds (VOCs), nitrogen oxides (NO_x) and particulate matter (PM₁₀), an evaluation of the impact of the alternatives on carbon monoxide levels at critical locations (microscale analysis), and an analysis of the impacts of the proposed ventilation buildings on carbon monoxide, nitrogen dioxide (NO₂) and PM₁₀ levels.

The assumptions and methodologies of the technical analysis described herein were developed in consultation with representatives of Massachusetts Department of Environmental Protection (MDEP), U.S. Environmental Protection Agency (EPA), the City of Boston, Massachusetts Highway Department (MHD), and the Federal Highway Administration (FHWA). These assumptions and methodologies were submitted to, and approved by, the MDEP and EPA in the Protocol for Air Quality Analysis for the Charles River Crossing Supplemental Environmental Impact Statement/Report, (B/PB, 1993).

2 PROJECT DESCRIPTION AND AFFECTED AREA

The three new design alternatives for the Charles River crossing considered for this analysis include; Alternative 8.1D Mod 5, the Non-River-Tunnel Alternative, and the Reduced River-Tunnel Alternative. Each alternative requires one ventilation building on the south bank of the river (designated Ventilation Building No. 8; VB 8). The Reduced River-Tunnel Alternative will require an additional ventilation building on the north bank of the river (designated Ventilation Building No. 9, VB 9). The locations of VB 8 and VB 9 are illustrated in Figure 2-1.

The sub-area of the project under air quality review, is essentially the Area North of Causeway Street, as described in the 1991 FSEIS/R (Fig. 2-2), since the ventilation buildings are located within this area. However, the evaluation of carbon monoxide levels at the most critical intersections covers a more extensive area from State Street downtown, Sullivan Square in the north and East Cambridge in the east. Also, the mesoscale emission evaluation considered the entire CA/T Project area, as defined in the 1991 FSEIS/R (Fig. 2-3).

3.0 SCOPE OF ANALYSIS

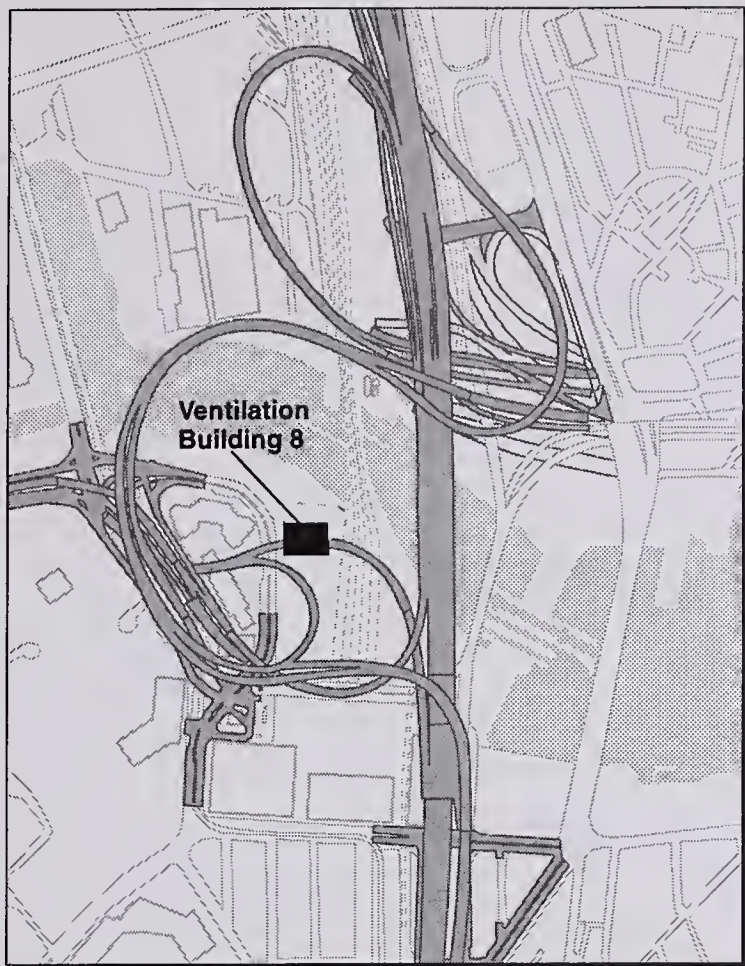
3.1 Applicable Air Quality Standards And Guidelines

MDEP's air pollution control regulations (310 CMR 7.38) require that prior to construction, the CA/T Project must certify that when operated, the tunnel ventilation system and the roadway network within the project area will not:

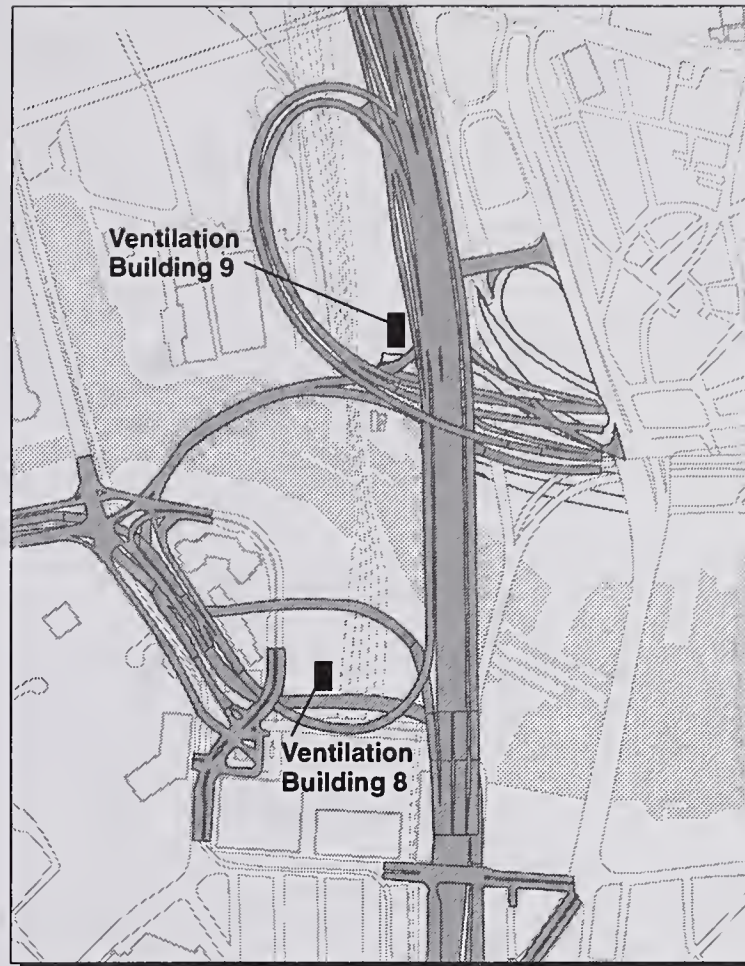
- cause or exacerbate a violation of any National or Massachusetts Ambient Air Quality Standards (AAQS), (Table 3-1) ;
- cause or exacerbate a violation of MDEP's one hour ambient nitrogen dioxide (NO₂) guideline of 320 µg/m³; and
- result in an actual or projected increase in the total amount of non-methane hydrocarbons (referred to in this report as volatile organic compounds or VOCs) measured within the Project area when compared with the no-build alternative.

On October 8, 1992, EPA published its final rule approving the Massachusetts' regulation for certifying roadway tunnel ventilation systems in the *Metropolitan Boston Air Pollution Control District* as a revision to the MSIP (57 FR 46310-46312). In the final rule, EPA concluded that tunnel ventilation systems are not stationary sources subject to Prevention of Significant Deterioration (PSD) or New Source Review permitting requirements of CAAA, or Regulation 310 CMR 7.02 of the MSIP.

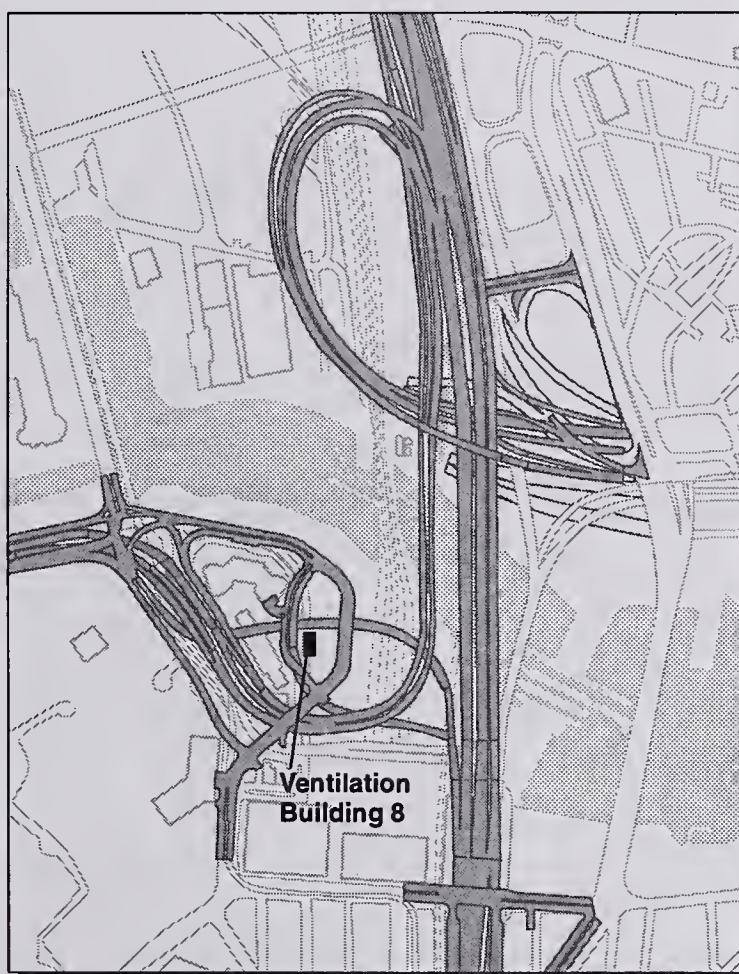
The 1990 CAAA requires federally-funded transportation projects located within carbon monoxide (CO) and ozone (O₃) non-attainment areas to eliminate or reduce the severity and number of violations of the CO standard in the area substantially affected by the project, to assist in reducing the volatile organic compounds (VOCs) and CO emissions for the affected area, when compared to the future no build scenario and to the 1990 baseline year emission levels of these pollutants.



Alternative 8.1D Mod 5



Reduced River-Tunnel Alternative



Non-River-Tunnel Alternative

FIGURE

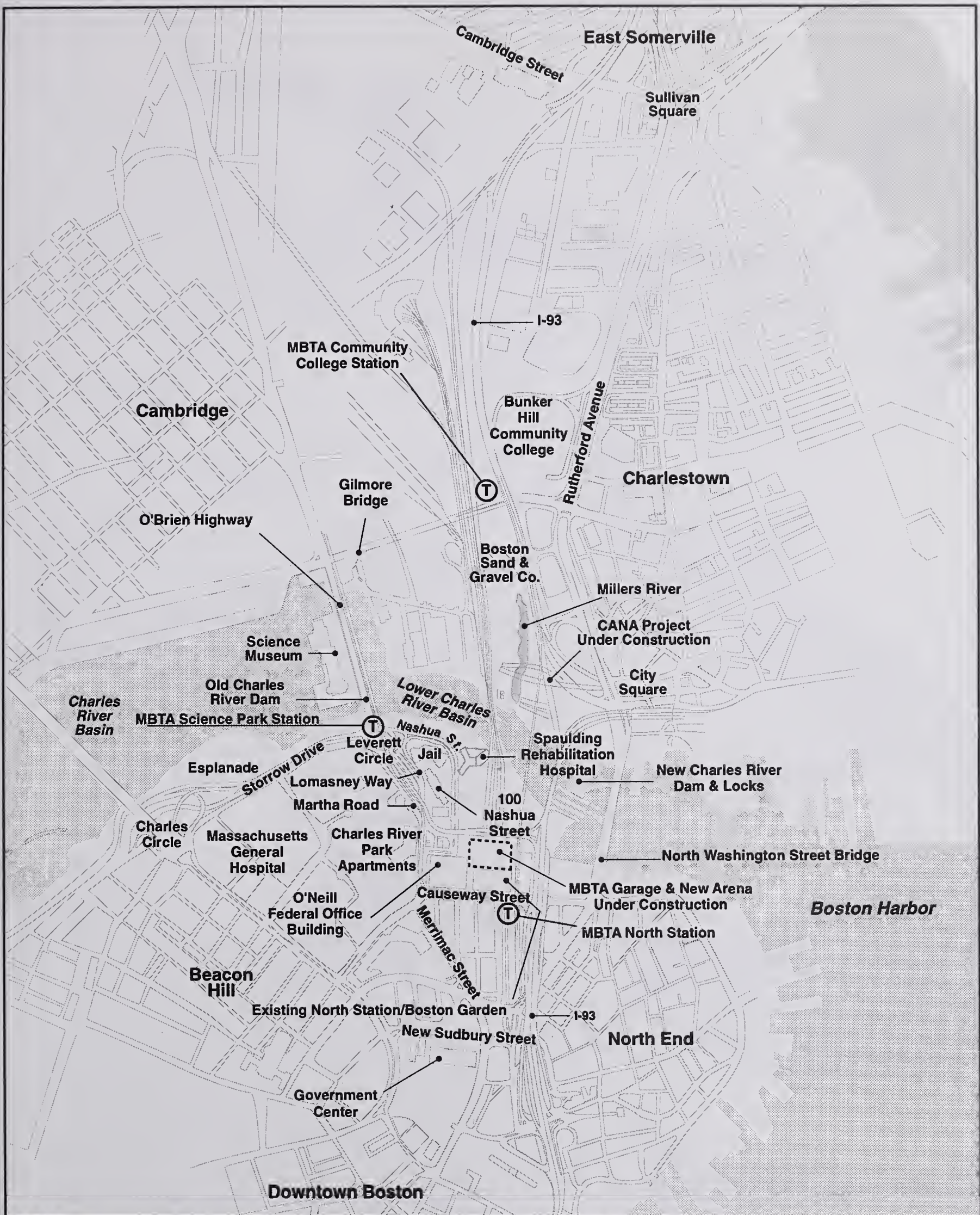
2.1

Proposed Locations for Ventilation Buildings

Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
CENTRAL ARTERY/TUNNEL PROJECT





FIGURE

2.2

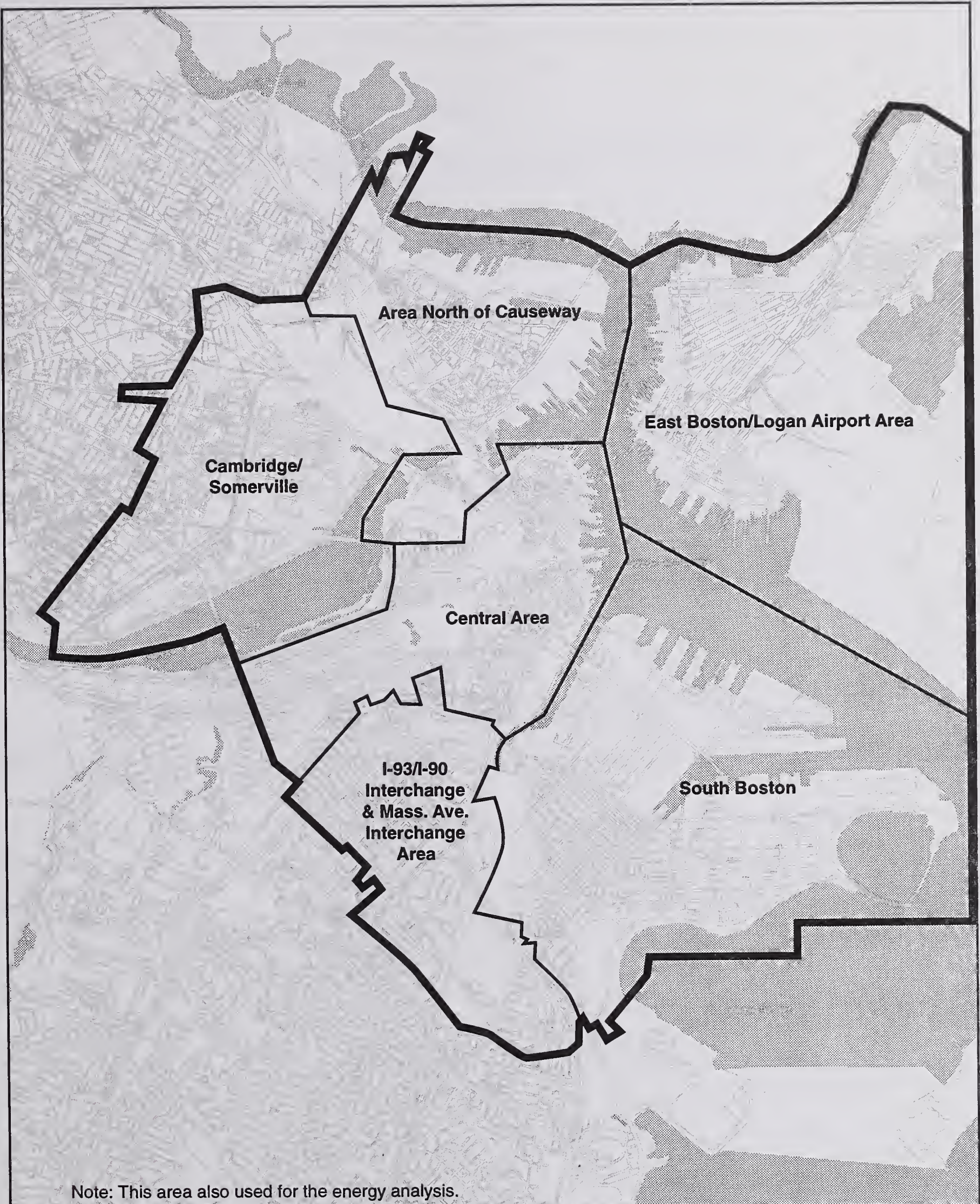
Area North of Causeway Street

Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
CENTRAL ARTERY/TUNNEL PROJECT

0 200 400 600 800 1000 FEET





FIGURE

2.3

Affected Zones For Mesoscale Air Quality Analysis

Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
CENTRAL ARTERY/TUNNEL PROJECT

0 800 1600 3200 4800 FEET



Table 3-1

NATIONAL AND STATE AMBIENT AIR QUALITY STANDARDS
(micrograms per cubic meter)

Pollutant	Averaging Period	<u>Primary</u>		<u>Secondary</u>	
Carbon Monoxide (CO)	8-hour ¹	10,000	(9.0 ppm)	10,000	
	1-hour ¹	40,000	(35.0 ppm)	40,000	
Sulfur Dioxide (SO ₂)	Annual	80	(0.03 ppm)		
	24-hour ¹	365	(0.14 ppm)		
	3-hour ¹			1,300	(0.5 ppm)
Nitrogen Dioxide (NO ₂) ³	Annual	100	(0.05 ppm)	100	
Ozone (O ₃)	1-hour ²	235	(0.12 ppm)	235	
PM ₁₀	Annual	50		50	
	24-hour ²	150		150	
Lead (Pb)	3-month	1.5		1.5	

1. Not to be exceeded more than once per calendar year

2. Not to be exceeded more than one day per calendar year

3. The Massachusetts Department of Environmental Protection has established a 1-hour guideline level of 320 ug/m³ for NO₂, with a corresponding significant impact level of 32 ug/m³

Sources: EPA, *National Primary and Secondary Ambient Air Quality Standards* (40 CFR 50)

Massachusetts DEP, *Massachusetts Ambient Air Quality Standards* (Title 310), April 20, 1978

3.2 POLLUTANTS FOR ANALYSIS

3.2.1 CRITERIA POLLUTANTS

Criteria pollutants are those pollutants for which AAQS have been established by the EPA. These are: CO, NO₂, O₃, PM₁₀, sulfur dioxide (SO₂) and lead (Pb). VOC levels are used as an indicator of regional O₃ levels, since they react in the atmosphere with NO_x to form O₃.

In evaluating the impacts due to the CA/T Project, those pollutants that can be traced principally, or in large measure, to motor vehicles were analyzed. These include CO, VOC, NO_x, O₃, PM₁₀, and Pb. Transportation sources account for a very small percentage of regional emissions of SO_x, therefore a detailed analysis for this pollutant was not warranted.

Although motor vehicles have historically constituted a major source of lead emissions to the atmosphere, lead levels have decreased significantly and are expected to continue to do so due to the mandated decrease and elimination of lead in gasoline. Therefore, a detailed analysis of the impact of lead emissions was also not warranted.

In this analysis, CO concentrations were estimated using a microscale mobile source and a ventilation building impact analysis. NO_x and VOCs were analyzed on a mesoscale (regional) basis to assess their potential effects on O₃. NO₂ emissions from the proposed ventilation buildings were analyzed on a microscale basis to permit comparison with the 1-hour MDEP policy level and the annual AAQS for NO₂. PM₁₀ was analyzed on a mesoscale basis, and on a microscale basis, in the vicinity of the proposed ventilation buildings for comparison with the AAQS.

3.2.2 NON-CRITERIA (TOXIC) POLLUTANTS

An assessment of the impacts resulting from toxic pollutants emitted from motor vehicles was provided in the CA/T 1991 FSEIS/R. As discussed in that assessment, the quantity of toxic air pollutants was found to be directly related to the level of VOCs emitted from the motor vehicles.

To evaluate the potential changes in air toxic concentrations expected under each of the proposed River Crossing alternatives, this study compared the changes in VOC emissions expected with each alternative against those of Scheme Z. This comparison provided a relative assessment of toxic air pollutants emitted between the three alternatives and the Scheme Z. No other air toxic assessment was made.

3.3 COMPLIANCE DEMONSTRATION OF PROJECT ALTERNATIVES

As mentioned in Section 1.0, the purpose of this study is to estimate the differences in the potential air quality impacts of the three new design alternatives as compared to Scheme Z. To make this comparison, two analysis years were considered. These are the year 2001 and 2010. Additionally, in order to be consistent with the requirements of the 1990 CAAA, a 1990 area-wide emission burden analysis was developed to estimate the 1990 "baseline" values.

Since the project is located in an area currently designated as non-attainment for O₃ and CO, the following analyses were performed to evaluate compliance.

1. CO levels (microscale analysis) were estimated at the most critical intersections that could be affected by the three project design alternatives. Since high CO levels are generally found

at intersections, this analysis evaluated those locations where project changes had the potential to cause or exacerbate a violation of the State and National AAQS.

2. Regional emissions (mesoscale analysis) of CO, VOCs, NO_x, and PM₁₀, generated in the study area, were estimated for each project alternative and compared to their corresponding emission levels in 1990. This comparison provided an indication of regional effect of the design alternatives for the above mentioned pollutants.

3. The potential impacts of the proposed ventilation buildings were estimated for CO, NO₂, and PM₁₀ in order to perform the required comparison to Scheme Z and also to demonstrate compliance with the AAQS and the MDEP NO₂ policy guideline.

4 EXISTING AMBIENT AIR QUALITY LEVELS

For the purpose of conducting an impact assessment, MDEP and EPA recommended that existing air quality levels be based on the most recent three years of readily available ambient air quality data. The MDEP has established monitoring stations in the Boston area for all criteria pollutants. The air quality assessment presented in the 1991 FSEIS/R was based on MDEP monitoring data for the years 1986, 1987, and 1988. The following updates that information.

Currently, the most recent three years of data available from the MDEP monitoring network are for the years 1989, 1990, and 1991. Presented below are summaries of monitored levels in the Boston area of CO, PM₁₀, NO₂, and O₃. The ambient levels are compared to National and Massachusetts AAQS.

4.1 CARBON MONOXIDE (CO)

Ambient CO data was obtained for the years 1989, 1990, and 1991 from MDEP monitoring stations, located at Kenmore Square (Cambridge), 340 Bremen Street (East Boston), and Visconti Street (East Boston). Data was also obtained from a fourth monitoring station, located at Post Office Square, for the years 1990 and 1991.

Highest and second-highest 1- and 8-hour CO concentrations, measured at each monitoring station, are shown on Table 4-1. No violations of the 1-hour AAQS (35 ppm), nor the 8-hour AAQS (9 ppm) were reported during 1989, 1990, and 1991. The highest, maximum 1- and 8-hour concentrations were 12.6 ppm and 8.9 ppm, respectively. These levels were measured at 340 Bremen Street during 1990. The highest, second highest 1- and 8-hour concentrations measured at Kenmore Square, were 11.0 ppm and 6.1 ppm, respectively.

4.2 PARTICULATE MATTER (PM₁₀)

Ambient PM₁₀ data was obtained for the years 1989, 1990, and 1991, from MDEP monitoring stations at Kenmore Square, 200 Columbus Avenue, Southampton Street, 340 Bremen Street, and One City Square in Charlestown.

The highest and second-highest 24-hour (daily) and annual average PM₁₀ concentrations for each monitoring station are listed on Table 4-2. No violations of the 24-hour AAQS (150 µg/m³) nor the annual AAQS (50 µg/m³) were reported during 1989, 1990, and 1991. The highest 24-hour concentration was 104 µg/m³, for the year 1990 at 200 Columbus Avenue. The second-highest

Table 4-1

**MAXIMUM AND SECOND-HIGHEST
1-HOUR AND 8-HOUR CO CONCENTRATIONS
MEASURED IN THE BOSTON METROPOLITAN AREA
(ppm)**

Site	Year	Highest 1-Hour	Second- Highest 1-Hour ¹	Highest 8-Hour	Second- Highest 8-Hour ²
Kenmore Square	1989	10.5	8.7	7.0	6.1
	1990	11.0	11.0	7.4	6.1
	1991	7.4	6.5	4.9	4.2
340 Bremen Street	1989	7.9	7.0	5.2	4.4
	1990	12.6	10.4	8.9	5.9
	1991	7.9	7.9	3.7	3.6
Post Office Square ³	1990	11.2	10.8	8.0	4.6
	1991	8.0	6.7	4.3	4.2
Visconti Street	1989	11.3	10.5	5.2	5.2
Callahan Tunnel	1990	9.0	9.0	5.9	5.8
	1991	7.9	7.2	5.3	4.2

1. CO 1-hour AAQS is 35 ppm.

2. CO 8-hour AAQS is 9 ppm.

3. Monitor started up in 1990.

Sources: Air Quality Data Reports for 1989 and 1990, Commonwealth of Massachusetts Department of Environmental Protection, Division of Air Quality Control; 1991 Annual Report of Air Quality in New England, Environmental Protection Agency, Region I, May 1992.

Table 4-2

**ANNUAL MEAN, HIGHEST AND SECOND-HIGHEST
DAILY PM₁₀ CONCENTRATIONS MEASURED IN THE
BOSTON METROPOLITAN AREA
(ug/m³)**

Site	Year	Highest Daily	Second- Highest Daily	Annual Mean
Kenmore Square	1989	55	54	32
	1990	56	52	27
	1991	51	51	27
200 Columbus Ave.	1989	58	54	30
	1990	104	73	30
	1991	52	46	25
One City Square	1989	78	75	36
	1990	96	69	38
	1991	68	65	33
Southampton Street	1989	58	53	26
	1990	74	49	24
	1991	57	51	23
340 Bremen Street	1989	53	51	24
	1990	71	45	22
	1991	53	53	24

1. PM₁₀ 24 hour AAQS is 150 ug/m³.
2. PM₁₀ Annual AAQS is 50 ug/m³.

Sources: Air Quality Data Reports for 1989 and 1990, Commonwealth of Massachusetts Department of Environmental Protection, Division of Air Quality Control; 1991 Annual Report of Air Quality in New England, Environmental Protection Agency, Region I, May 1992.

24-hour concentration was 75 $\mu\text{g}/\text{m}^3$, for the year 1989 at One City Square. The highest annual concentration was 38 $\mu\text{g}/\text{m}^3$, for the year 1990 at One City Square.

4.3 NITROGEN DIOXIDE (NO_2)

Ambient NO_2 data was obtained for the years 1989, 1990, and 1991, from MDEP monitoring stations located at Kenmore Square, 340 Bremen Street, and Powder Horn Hill in Chelsea. A summary of these data is provided on Table 4-3.

The monitored data for this period shows no violations of the annual AAQS (100 $\mu\text{g}/\text{m}^3$) or the MDEP 1-Hour Policy Guideline level of 320 $\mu\text{g}/\text{m}^3$, which is not to be exceeded more than once per calendar year. The highest annual level was 66 $\mu\text{g}/\text{m}^3$ for the year 1991 at Kenmore Square. The highest 1-hour concentration was 470 $\mu\text{g}/\text{m}^3$ for the year 1990 at 340 Bremen Street. The second-highest 1-hour concentration was 295 $\mu\text{g}/\text{m}^3$, for the year 1989 at Powder Horn Hill.

4.4 OZONE (O_3)

Ambient O_3 data was obtained from the MDEP operated continuous monitoring station at Powder Horn Hill, in Chelsea, as well as the other MDEP monitoring stations in Sudbury, Scituate, Waltham, and Lexington.

Table 4-4 lists the available daily, highest and second-highest 1-hour concentrations for each monitoring station for the years 1989, 1990, and 1991. Also provided in the table, are the number of days for which the 1-hour AAQS (0.125 ppm) was exceeded.

As shown on Table 4-4, exceedances of the 1-hour AAQS were reported at Waltham, Scituate and Sudbury during 1991. No exceedance of the AAQS was reported at any monitoring station during 1989 and 1990.

5 PROJECT EMISSIONS

The relative air quality impacts of the three design alternatives are directly related to how these alternatives affect vehicular emissions. Localized (microscale), areawide (mesoscale), and ventilation building air quality impacts all result from motor vehicle emissions. Changes in traffic volumes, traffic patterns, vehicular speeds, and roadway configurations affect both the amount of pollution generated and how it is dispersed within the affected area.

5.1 EMISSION FACTORS for CO , VOCs and NO_x

The EPA periodically updates its mobile source emissions estimation model to conform with the most currently available engine test data, to reflect current vehicle control technologies and to forecast the effects of mandated emission control requirements. In this study, motor vehicle emission rates for CO , VOCs, and NO_x were estimated using the EPA MOBILE 5a Mobile Source Emission Factor Model (EPA-AA-TEB-92); the most current available version. Since MOBILE 5a does not produce emission factors for idling conditions, factors generated by the MOBILE 4.1 (EPA-AA-TEB-91-01) were used to estimate idle emissions.

Vehicular emissions are affected by vehicular speed, ambient temperature, engine temperature (thermal state), vehicle age and mileage distribution, inspection and maintenance programs, fuel

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Table 4-3

**ANNUAL MEAN, MAXIMUM HOURLY, AND
SECOND-HIGHEST HOURLY NO₂ CONCENTRATIONS
MEASURED IN THE BOSTON METROPOLITAN AREA
(ug/m³)**

Site	Year	Highest 1-Hour¹	Second-Highest 1-Hour¹	Annual Mean²
Kenmore Square	1989	254	252	60
	1990	301	237	56
	1991	290	282	66
340 Bremen Street	1989	216	197	60
	1990	470	207	60
	1991	173	167	60
Chelsea (Powder Horn Hill)	1989	335	295	56
	1990	186	180	49
	1991	171	164	51

1. DEP 1-hour NO₂ policy guideline is 320 ug/m³.

2. Annual AAQS is 100 ug/m³.

Sources: Air Quality Data Reports for 1989 and 1990, Commonwealth of Massachusetts Department of Environmental Protection, Division of Air Quality Control; 1991 Annual Report of Air Quality in New England, Environmental Protection Agency, Region I, May 1992.

Table 4-4

**HIGHEST AND SECOND-HIGHEST
HOURLY OZONE CONCENTRATIONS
MEASURED IN THE BOSTON METROPOLITAN AREA
(ppm)**

Site	Year	Highest Concentration	Second Highest Concentration	Number of Days Standard Was Exceeded ¹
Chelsea	1989	0.123	0.114	0
	1990	0.137	0.107	0
	1991	0.126	0.122	0
Sudbury	1989	0.122	0.120	0
	1990	0.137	0.099	0
	1991	0.127	0.126	1
Scituate	1989	0.131	0.118	0
	1990	0.095	0.090	0
	1991	0.128	0.126	1
Waltham	1989	0.122	0.113	0
	1990	0.143	0.109	0
	1991	0.161	0.130	2
Lexington ²	1991	0.114	0.114	0

1. The AAQS states that the expected number of days per calendar year with daily maximum ozone concentrations exceeding 0.125 ppm must be less than, or equal to one.
2. Monitor started up in 1991.

Sources: Air Quality Data Reports for 1989 and 1990, Commonwealth of Massachusetts Department of Environmental Protection, Division of Air Quality Control; 1991 Annual Report of Air Quality in New England, Environmental Protection Agency, Region I, May 1992.

volatility and other localized parameters. While the selection criteria for most of the input parameters was established in the original 1989 Protocol, some parameters have been revised to; reflect changes mandated by the 1990 CAAA, to include new options available in the current version of the model, and to be consistent with the 1990 emission inventory prepared by MDEP.

The following are parameters and model-specific flags used in MOBILE 4.1/5a algorithms:

TAMFLG	= 1	Default Tampering Rates
SPDFLG	= 1	Same speed for all vehicles for all speed ranges of a roadway link
VMFLG	= 3	Project-specific vehicle classification data based on traffic counts (truck percentage) for each area, as described in the 1991 FSEIS/R, and National (Mobile 5a) estimates for percentage of diesel vehicles and motorcycles.
MYMRFG	= 3	Massachusetts annual registration data (DEP-March, 1993) and National mileage accumulation rates.
NEWFLG	= 1	Default basic exhaust emission rates.
IMFLG	= 2	Massachusetts Inspection and Maintenance Program: Start Year 1983, 12% stringency level, covers 15 year old vehicles, 1% waiver rates, 85% compliance rate, annual/decentralized/computerized, covers idle test for LDGV, LDGT1, and LDGT2.
ATPFLG	= 1	No anti-tampering program modeled.
RLFLAG	= 2	Stage II vapor recovery program started 1991, phase in 3 years, 95% efficiency.
LOCFLG	= 2	Local area parameters as recommended by MDEP and EPA include: Reid Vapor Pressure = 11.5 - 8.5 PSI summer season started in 1989. Diesel sales fraction = 1, no oxygenated fuels = 1, reformulated gasoline = 2
TEMFLG	= 1	Daily minimum and maximum temperatures will be used to calculate evaporative and refueling emissions as specified in LOGFLG
NMHFLG	= 3	Volatile Organic Compounds (VOCs) will be calculated.
Time of year	=	January for CO, season = 1, July for NO _x and VOCs, season = 7.

For automobiles and light-duty gasoline-powered trucks, emission estimates account for three possible operation conditions: cold-vehicle operation, hot-start operation, and hot-stabilized operation. It is important to distinguish among these three operating categories because vehicles emit CO at different rates depending on whether they are cold or warmed up (hot-stabilized). For vehicles traveling on local roads and Central Artery entrance ramps, 15% were assumed to be operating in the cold-start mode and 20% in the hot-start mode, the remaining 65% were assumed to be operating in the hot-stabilized mode. For vehicles traveling on the Central Artery or on exit ramps, 5% were

assumed to be operating in the cold-start mode and 5% in the hot-start mode. These are the same values utilized in the 1991 FSEIS/R.

O₃ formation is of primary concern during summer. Daily pollutant emissions for VOCs and NO_x were estimated assuming minimum and maximum summer temperatures of 67.5°F and 94.4°F, respectively, to determine the maximum potential effects on peak O₃ levels. These conditions represent the average minimum and maximum temperatures recorded in the Boston area during the ten days when O₃ levels were at their highest in the past three years.

Due to colder engine temperatures, vehicular emissions of CO are greater during the winter. Emissions of CO were estimated assuming minimum and maximum winter temperatures of 34°F and 50°F, respectively. These temperatures are consistent with those used by the MDEP in their emission inventory, and is in agreement with the temperature of those days with the highest monitored CO levels.

5.2 PM₁₀ EMISSION FACTORS

Motor vehicle-related sources of PM₁₀ include emissions from vehicle tailpipes, brakes, tire wear, and re-entrained road dust. PM₁₀ emissions from tailpipes, brakes, and tire wear were estimated using the EPA-PART Program (*A Program to Calculate Size Specific Particulate Emissions from Mobile Sources* (EPA 460/3-85-007)). Fugitive dust emissions for re-entrained road dust were estimated using the most recent version of the *Compilation of Air Pollutant Factors* (EPA AP-42, Sept. 1985). These estimated values are the same as the ones used in the 1991 FSEIS/R since no update to the emission factor models for PM₁₀ has been produced recently.

6 MOBILE SOURCE ANALYSIS

6.1 MICROSCALE ANALYSIS

The mobile source microscale analysis estimated ambient levels of CO near the major congested intersections which were potentially affected by the project alternatives. The analysis was primarily designed to determine whether any of the alternatives would cause or exacerbate an exceedance of the CO AAQS. The analysis also compared estimated CO levels at these intersections among the three new design alternatives and to the proposed action (Scheme Z) to determine which alternative would result in the smallest increase in CO levels. Due to the previously mentioned changes in the forecasting emission models and mandates of the 1990 CAAA, Scheme Z was re-analyzed in order to permit a direct comparison with the new design alternatives.

CO levels were estimated at each selected intersection for the year 2001 and 2010. Peak 1-hour and 8-hour CO levels were estimated. The resulting CO levels were also compared with the AAQS in order to determine compliance with the 1990 CAAA and the MSIP.

6.1.1 ANALYSIS SITES

The primary goals of selecting mobile source analysis sites was to select sites that:

- were geographically distributed throughout the affected area;

- were located along major congested corridors;
- were heavily congested during peak hour traffic periods; and,
- had the potential for the highest impacts that could be expected to occur due to the three proposed alternatives.

For each site, detailed geometries of all major roadway links surrounding receptor locations were included. A link length of 500 - 1,000 ft from each intersection was modeled, depending on geometry and obstructions created by buildings for each specific roadway link. Major roadways within 500 - 1,000 ft of each intersection were included in this analysis regardless of whether the roadway and intersection actually cross.

Based on a review of preliminary traffic data, site visits, discussions with Bechtel/Parsons Brinckerhoff traffic engineers and personnel from MDEP and EPA, a list of 23 intersections were selected for analysis (Figure 6-1). These intersections were selected based on estimated future traffic conditions and a comparison of preliminary traffic data for Scheme Z with data developed for Alternative 8.1D Mod 5. The locations where greatest air quality impacts are expected to occur were included. A list of proposed intersections for the analysis was submitted to MDEP and EPA at the February 16, 1993 Technical Committee Meeting, and was subsequently agreed to by these agencies in the Protocol for Air Quality Analysis.

6.1.2 RECEPTOR PLACEMENT

The locations at which pollutant concentrations are estimated are known as "receptors." As a general rule, following guidelines established by the EPA, receptors are to be located where the maximum projected total concentration is likely to occur and where the general public is likely to have access. For major congested urban areas receptors are usually located on sidewalks.

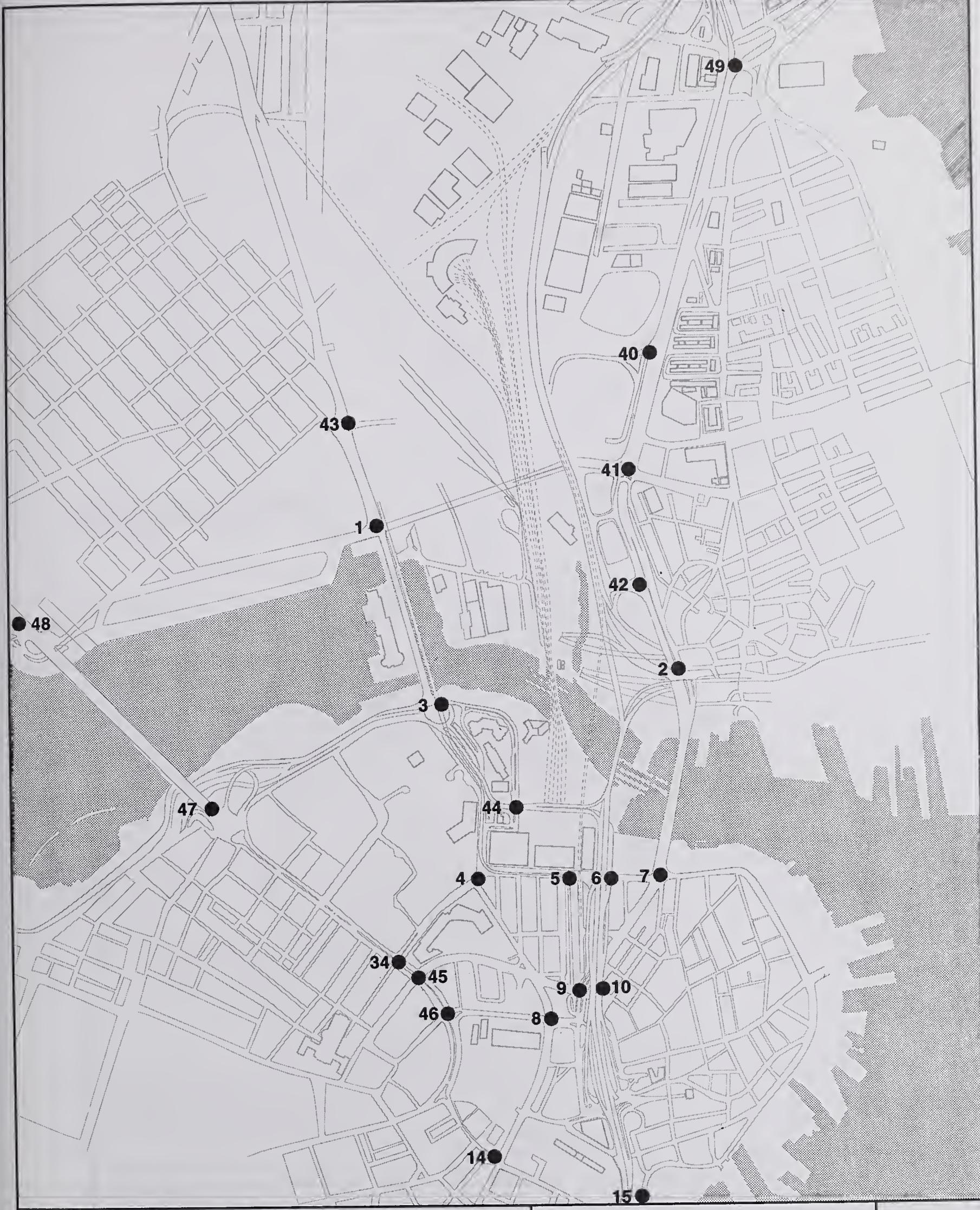
For this study, receptors were distributed along sidewalks near the major roadway links surrounding each analysis site. The exact placement of these receptors was determined on a site-by-site basis based on traffic conditions, roadway geometry, building locations, and the potential for public access on a continuous basis.

The placement of receptors followed the *EPA Guidelines For Modeling Carbon Monoxide at Roadway Intersections* (EPA-454/R-92-005). These guidelines require a receptor to be located outside of the turbulent "mixing zone" created by the moving traffic. A mixing zone is the width of the travelled (or moving) lane or lanes of traffic plus 3 m (approximately 10 ft) on either side of this width. The calculation of vehicle turbulence does not allow current models to make valid concentration estimates within this mixing zone.

The number of receptors placed at each analysis site varied typically from 10 to 18 depending on the complexity of the intersection. Figure 6-2 shows an example of the receptor locations, freeflow and queue links for the intersection of North Washington and Commercial Streets at Keany Square. (The same level of detail for each analysis site is reproduced in the Technical Support Document for the Mobile Source Air Quality Analysis).

6.1.3 TRAFFIC DATA

Traffic data for the air quality analysis were derived from traffic counts, speed data, and other information developed as a part of the traffic analysis for the DSEIS/R. The microscale CO analysis was based on estimates of average traffic conditions during the peak 8-hour traffic period (10 AM to



FIGURE

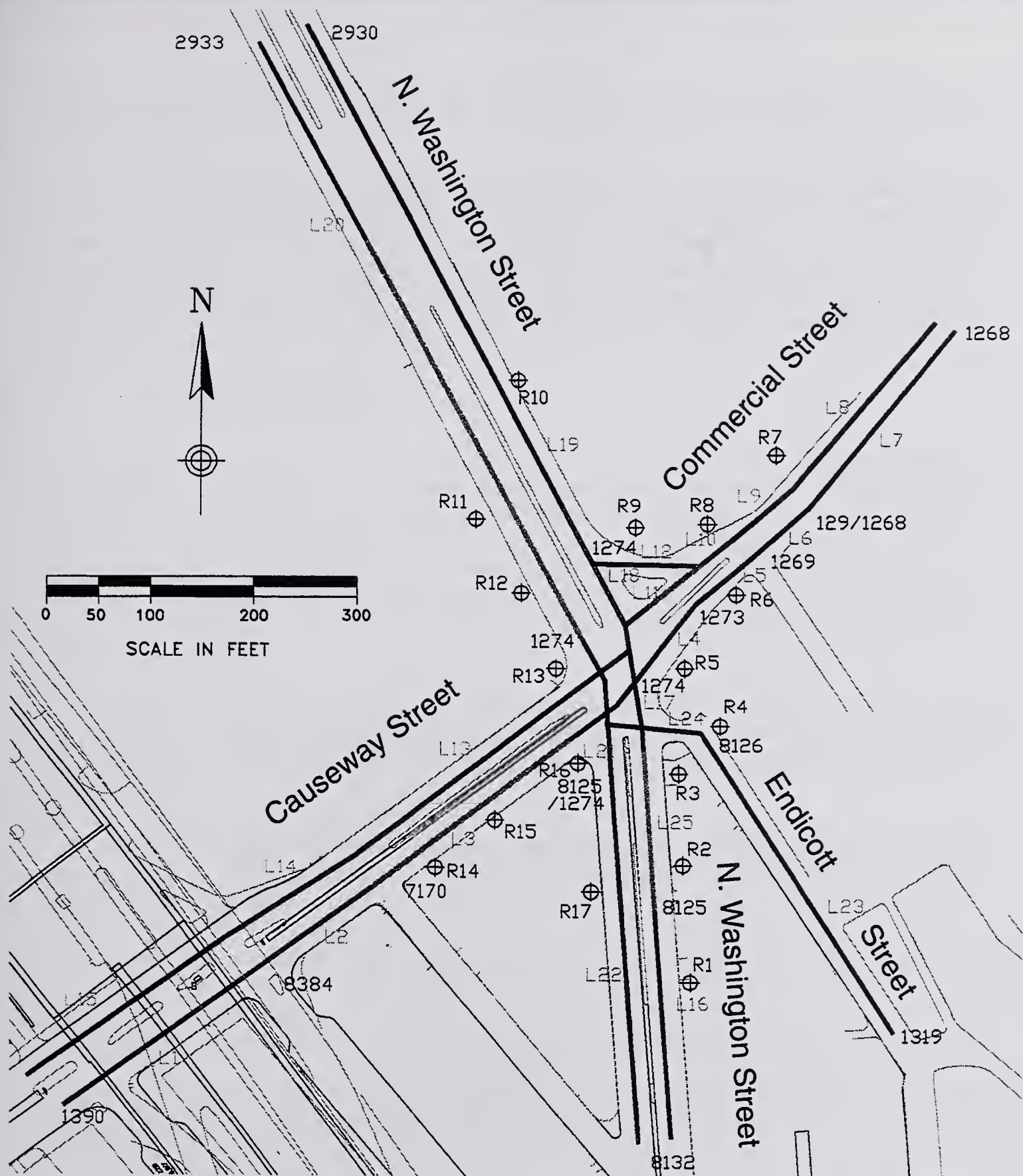
6.1

Location of Mobile Sources
Carbon Monoxide Modeling Sites
Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
CENTRAL ARTERY/TUNNEL PROJECT

0 200 400 600 800 1000 FEET





INTEGRATED CADD/AIR QUALITY ANALYSIS PROGRAM
DEVELOPED AT PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

JOB: CHARLES RIVER CROSSING EIS
RUN: ALL ALTERNATIVES AT SITE 7
(Washington & Commercial)

DATE: 6/17/93

Dispersion Model: CAL3QHC (v. 2.0)

LEGEND:

⊕ receptor location
— freeflow link
— queue link

● link boundaries
8132 link node number
L14 link label

Emissions Model: MOBILE 5A

FIGURE 6.2
Receptor Locations, Free-Flow And Queue Links For Site 7 At Keany Square
Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
CENTRAL ARTERY /TUNNEL PROJECT



6 PM). This is the period when the greatest traffic volumes and highest air quality levels would be expected to occur.

Traffic volumes and speeds were predicted using the TRANPLAN model for each scenario analyzed. The TRANPLAN network used for all scenarios analyzed (including Scheme Z) incorporates all the changes that have occurred since the publication of the 1991 FSEIS/R. The speeds projected by the TRANPLAN model were adjusted to reflect appropriate delays and the capacity constraints for the specific locations analyzed. Signal timing, saturation flow rates and progression factors were estimated for each specific intersection based on the optimization of these parameters for the future scenarios.

6.1.4 DISPERSION MODEL

Mobile source models are the basic analytical tools used to estimate CO concentrations expected under given traffic, roadway geometry, and meteorological conditions. The mathematical expressions and formulations that comprise the various models attempt to describe an extremely complex physical phenomenon as closely as possible. The dispersion modeling program used in this study for estimating pollutant concentrations near roadway intersections is the CAL3QHC dispersion model (Version 2.0) developed by the U.S. Environmental Protection Agency (EPA). This version 2.0, released in 1992, allows a more specific determination of the traffic characteristics occurring at a roadway intersection.

CAL3QHC is a Gaussian model recommended in the *EPA Guidelines for Modeling Carbon Monoxide From Roadway Intersections* (EPA-454/R-92-005). Gaussian models assume that the dispersion of pollutants downwind of a pollution source follow a normal distribution around the center of the pollution source.

Different emission rates occur when vehicles are stopped (idling), accelerating, decelerating, and moving at different average speeds. CAL3QHC simplifies these different emission rates into the following two components:

- Emissions when vehicles are stopped (idling) during the red phase of a signalized intersection, and
- Emissions when vehicles are in motion during the green phase of a signalized intersection.

A complete description of the model can be found in the *User's Guide To CAL3QHC, Version 2.0, A Modeling Methodology For Predicting Pollutant Concentrations Near Roadway Intersections* (EPA-454/12-92-006).

6.1.5 METEOROLOGICAL CONDITIONS

The transport and concentration of pollutants emitted from motor vehicles are influenced by three principal meteorological factors: wind direction, wind speed, and the temperature profile of the atmosphere. In applying the CAL3QHC model, values for these parameters were chosen to result in worst case pollutant concentrations at each prediction site.

At each receptor, the approximate wind direction that would result in maximum pollutant concentrations was reported in the analysis. Wind directions, ranging from 0° to 360°, at 10° increments were analyzed.

CO concentrations are greatest at low wind speeds. Therefore, a wind speed of 1 m/s was used to predict CO concentrations during peak traffic periods.

To model the mechanical turbulence created by buildings, a surface roughness coefficient of 370 cm (representative of apartment buildings) was used for the Central Area. A surface roughness coefficient of 108 cm (representative of one- or two-story buildings) was used for Charlestown, Cambridge and Somerville.

Maximum CO concentrations occur when the temperature is low, the height in the atmosphere to which pollutants will rise is low (mixing height), and when there is little variation between the temperature found at ground level and the temperature found at elevated heights in the atmosphere (neutral atmospheric conditions). A mixing height of 1,000 m, and "neutral" atmospheric stability conditions were used in estimating microscale CO concentrations.

CO concentrations were then modeled assuming the simultaneous occurrence of low wind speeds, low vertical mixing height, neutral atmospheric conditions, and a constant wind direction for the time period analyzed. This set of conditions are expected to generate the maximum concentration expected to occur at each receptor site.

6.1.6 BACKGROUND CO LEVELS

Evaluation of total ambient air quality requires the inclusion of background levels. Background level is the component of the total concentration not accounted for through the microscale modeling analysis. Applicable background concentrations are added to the modeling results to obtain the total pollutant concentration at each receptor site for each analysis year.

Determination of the background levels for use on this analysis followed the same methodology as in the 1991 FSEIS/R.

A 5 ppm value for the 1-hour period, and a 3 ppm value for the 8-hour period was used as the 1990 base year background. These values are based on a CO background monitor operated by MDEP during the 1980's.

Since CO levels are decreasing due to cleaner motor vehicles, the background concentrations for future years were estimated using the roll-back technique described in the EPA modeling guidelines. This technique takes into consideration the effects of changes in motor vehicle emissions (Mobile 5a emission rates) and the increase in traffic levels on an areawide basis. It also considers that:

- Ten percent of the CO emissions in the region are currently from sources other than vehicular emissions, and that this level will remain constant for the years 2001 and 2010.
- Ten percent of the CO emissions in the region are generated by motor vehicles travelling in the Project study area. Emissions from this traffic was adjusted based on the changes in emissions predicted by the mesoscale analysis.
- Eighty percent of the CO emissions in the region are generated by motor vehicles travelling outside of the Project study area. Emissions from this traffic was based on estimated future reductions in vehicular emission rates and a sixteen percent traffic increase between 1990 and 2001, and a thirty-two percent traffic increase between 1990 and 2010.

The estimated future background levels are provided in Table 6-1.

6.1.7 PERSISTENCE FACTOR

At the request of the EPA Region I, the analysis for the 8-hour peak CO concentrations was directly modeled at each microscale receptor site. The associated traffic conditions for the peak 8-hour period occurs from 10 AM to 6 PM. Consequently, the modeling analysis evaluated the average hourly traffic condition for this time period, using the worst case meteorological conditions as described in Section 6.1.5. (Since these worst case meteorological conditions are the same as the ones recommended for the peak hour analysis under EPA guidelines, the results are expected to be a conservative worst case scenario for the 8-hour CO levels).

Peak 1-hour CO concentrations will be obtained by dividing peak 8-hour CO estimates by a persistence factor of 0.6. This is the same factor developed for the 1991 FSEIS/R and it is based in the ratio of the ten highest 8-hour/1-hour monitored levels at several MDEP monitors. This adjustment accounts for the fact that vehicle volumes, vehicle speeds, and meteorological conditions over 8 hours will vary from those which persist for only one hour.

6.1.8 ESTIMATED FUTURE CO LEVELS BASED ON MICROSCALE MODELING

The results of the CO microscale analysis are summarized in Tables 6-2 to 6-5. Provided are estimates of the highest 1-hour and 8-hour concentrations of CO for each of the 23 intersections analyzed for Scheme Z and the three Charles River Crossing alternatives for the years 2001 and 2010. The results of the analysis indicate that:

- One- hour and eight- hour CO concentrations in 2001 for all scenarios analyzed will be less than (in compliance with) the National and State AAQS of 35 ppm and 9 ppm at all locations analyzed. The maximum one- hour and eight- hour CO concentrations (13.0 parts per million (ppm) and 7.8 ppm) in 2001 was estimated near the intersection of North Washington and Commercial Streets for Scheme Z.
- One- hour and eight- hour CO concentrations in 2010 for all scenarios analyzed will be less than (in compliance with) the National and State AAQS of 35 ppm and 9 ppm at all locations analyzed. The maximum one- hour and eight- hour CO concentrations (13.6 ppm and 8.1 ppm) in 2010 was estimated near the intersection of North Washington and Commercial Streets for Scheme Z.

6.1.9 COMPARISONS OF ALTERNATIVES

For the three new design alternatives predicted CO levels at most of the 23 intersections analyzed are very similar and slightly lower than the levels predicted for Scheme Z, the principal reasons for these slightly lower CO levels are better traffic operations in local and arterial streets, with the proposed alternatives.

There are a few intersections where the eight- hour CO levels are significantly lower (better) than for Scheme Z. These include: City Square, Cambridge/New Chardon and Cambridge/New Sudbury for all three alternatives; and Leverett Circle and New Rutherford @ BS&G for the Reduced River-Tunnel. In addition, for the year 2010 only, CO levels deteriorate at Leverett Circle for Alternative 8.1D Mod. 5 and at New Chardon/Stillman/North Washington for all three alternatives.

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Table 6-1

**CARBON MONOXIDE BACKGROUND LEVELS
(ppm)**

	1990	2001	2010
1-hour average	5.0 ¹	4.0	4.4
8-hour average	3.0 ¹	2.4	2.6

-
1. Based on 1-hour and 8-hour CO levels recorded at the DEP CO monitor located in the Charlestown Navy Yard

Source: Bechtel/Parsons Brinckerhoff

Table 6-2

**ESTIMATED 1-HOUR WORST CASE
CARBON MONOXIDE LEVELS IN 2001^{1,2}
(ppm)**

No.	Location	Project Alternatives			
		Scheme Z	8.1DMOD5	Non-River-Tunnel	Reduced River-Tunnel
1	Gilmore Bridge and O'Brien Highway	11.0	11.2	11.0	11.0
2	City Square	12.2	8.3	8.2	7.7
3	Leverett Circle	9.2	9.3	9.2	8.7
4	Causeway/Merrimac/Lomasney	12.8	11.3	12.3	10.8
5	Causeway and Haverhill Streets	9.0	8.8	8.0	8.8
6	Causeway and Beverly Streets	9.0	8.8	8.7	8.7
7	North Washington and Commercial (Keany Sq.)	13.0	12.3	12.7	12.7
8	New Sudbury and Congress Streets	9.5	8.8	9.8	8.8
9	New Chardon/Haverhill/North Washington	10.2	9.7	10.5	9.8
10	New Chardon/Stillman/North Washington	9.7	10.2	10.2	10.3
14	Congress and State Streets	6.5	6.7	6.5	6.5
15	State Street and Surface Road	9.5	9.2	9.2	9.2
34	Cambridge and Staniford Streets	12.0	11.5	11.7	11.7
40	New Rutherford/C-L @ Bunker Hill College	9.2	9.8	9.7	9.5
41	New Rutherford & Gilmore Bridge	8.8	8.7	8.7	8.5
42	New Rutherford/BS & G	9.5	8.3	8.7	8.2
43	Lechmere Square	8.0	7.8	8.0	7.8
44	Nashua Street and Martha Rd.	10.8	10.3	10.3	10.2
45	Cambridge St. & New Chardon	11.7	10.8	10.5	10.8
46	Cambridge St. & New Sudbury	11.8	11.0	10.5	11.0
47	Charles Circle	9.2	8.8	9.3	9.2
48	Broadway & 3rd Street	5.8	5.8	5.8	5.8
49	Sullivan Square	8.5	8.3	8.2	8.2

1. One-hour AAQS for carbon monoxide = 35 ppm

2. Values include 1-hour CO background level of 4.0 ppm.

3. Analysis sites numbered 1 to 34 coincide with the numbering utilized in the 1990 SFEIS/R, sites 40 to 49 are new sites.

Source: Bechtel/Parsons Brinckerhoff

Table 6-3

**ESTIMATED 8-HOUR WORST CASE
CARBON MONOXIDE LEVELS IN 2001^{1,2}**
(ppm)

No.	Location	Project Alternatives			
		Scheme Z	8.1DMOD5	Non-River-Tunnel	Reduced River-Tunnel
1	Gilmore Bridge and O'Brien Highway	6.6	6.7	6.6	6.6
2	City Square	7.3	5.0	4.9	4.6
3	Leverett Circle	5.5	5.6	5.5	5.2
4	Causeway/Merrimac/Lomasney	7.7	6.8	7.4	6.5
5	Causeway and Haverhill Streets	5.4	5.3	4.8	5.3
6	Causeway and Beverly Streets	5.4	5.3	5.2	5.2
7	North Washington and Commercial (Keaney Sq.)	7.8	7.4	7.6	7.6
8	New Sudbury and Congress Streets	5.7	5.3	5.9	5.3
9	New Chardon/Haverhill/North Washington	6.1	5.8	6.3	5.9
10	New Chardon/Stillman/North Washington	5.8	6.1	6.1	6.2
14	Congress and State Streets	3.9	4.0	3.9	3.9
15	State Street and Surface Road	5.7	5.5	5.5	5.5
34	Cambridge and Staniford Streets	7.2	6.9	7.0	7.0
40	New Rutherford/C-L @ Bunker Hill College	5.5	5.9	5.8	5.7
41	New Rutherford & Gilmore Bridge	5.3	5.2	5.2	5.1
42	New Rutherford/BS & G	5.7	5.0	5.2	4.9
43	Lechmere Square	4.8	4.7	4.8	4.7
44	Nashua Street and Martha Rd.	6.5	6.2	6.2	6.1
45	Cambridge St. & New Chardon	7.0	6.5	6.3	6.5
46	Cambridge St. & New Sudbury	7.1	6.6	6.3	6.6
47	Charles Circle	5.5	5.3	5.6	5.5
48	Broadway & 3rd Street	3.5	3.5	3.5	3.5
49	Sullivan Square	5.1	5.0	4.9	4.9

1. Eight-hour AAQS for carbon monoxide = 9 ppm

2. Values include 8-hour CO background level of 2.4 ppm

3. Analysis sites numbered 1 to 34 coincide with the numbering utilized in the 1990 SFEIS/R, sites 40 to 49 are new sites.

Source: Bechtel/Parsons Brinckerhoff

Table 6-4

**ESTIMATED 1-HOUR WORST CASE
CARBON MONOXIDE LEVELS IN 2010^{1,2}
(ppm)**

No.	Location	Project Alternatives			
		Scheme Z	8.1DMOD5	Non-River-Tunnel	Reduced River-Tunnel
1	Gilmore Bridge and O'Brien Highway	12.2	12.6	12.6	12.4
2	City Square	12.1	9.1	8.7	8.7
3	Leverett Circle	10.4	11.7	9.7	9.2
4	Causeway/Merrimac/Lomasney	12.9	12.4	12.1	12.2
5	Causeway and Haverhill Streets	9.7	9.9	9.7	9.7
6	Causeway and Beverly Streets	9.7	9.7	9.2	9.2
7	North Washington and Commercial (Keany Sq.)	13.6	12.9	13.1	12.9
8	New Sudbury and Congress Streets	10.1	9.9	9.7	9.7
9	New Chardon/Haverhill/North Washington	10.6	10.1	10.6	9.9
10	New Chardon/Stillman/North Washington	10.1	11.1	11.1	11.4
14	Congress and State Streets	8.4	8.6	8.4	8.1
15	State Street and Surface Road	9.7	9.7	9.7	9.7
34	Cambridge and Staniford Streets	12.2	12.1	11.7	11.9
40	New Rutherford/C-L @ Bunker Hill College	9.7	10.2	9.7	9.7
41	New Rutherford & Gilmore Bridge	9.9	9.2	9.2	9.2
42	New Rutherford/BS & G	10.1	9.6	9.6	8.9
43	Lechmere Square	8.4	8.2	8.2	8.4
44	Nashua Street and Martha Rd.	11.9	11.7	10.6	11.9
45	Cambridge St. & New Chardon	11.9	11.1	10.9	11.1
46	Cambridge St. & New Sudbury	12.2	11.2	11.1	11.2
47	Charles Circle	9.9	9.9	9.9	9.9
48	Broadway & 3rd Street	6.4	6.2	6.4	6.4
49	Sullivan Square	8.9	8.2	8.4	8.4

1. One-hour AAQS for carbon monoxide = 35 ppm

2. Values include 1-hour CO background level of 4.4 ppm

3. Analysis sites numbered 1 to 34 coincide with the numbering utilized in the 1990 SFEIS/R, sites 40 to 49 are new sites.

Source: Bechtel/Parsons Brinckerhoff

Table 6-5

**ESTIMATED 8-HOUR WORST CASE
CARBON MONOXIDE LEVELS IN 2010^{1,2}
(ppm)**

No.	Location	Project Alternatives			
		Scheme Z	8.1DMOD5	Non-River-Tunnel	Reduced-River Tunnel
1	Gilmore Bridge and O'Brien Highway	7.3	7.5	7.5	7.4
2	City Square	7.2	5.4	5.2	5.2
3	Leverett Circle	6.2	7.0	5.8	5.5
4	Causeway/Merrimac/Lomasney	7.7	7.4	7.2	7.3
5	Causeway and Haverhill Streets	5.8	5.9	5.8	5.8
6	Causeway and Beverly Streets	5.8	5.8	5.5	5.5
7	North Washington and Commercial (Keany Sq.)	8.1	7.7	7.8	7.7
8	New Sudbury and Congress Streets	6.0	5.9	5.8	5.8
9	New Chardon/Haverhill/North Washington	6.3	6.0	6.3	5.9
10	New Chardon/Stillman/North Washington	6.0	6.6	6.6	6.8
14	Congress and State Streets	5.0	5.1	5.0	4.8
15	State Street and Surface Road	5.8	5.8	5.8	5.8
34	Cambridge and Staniford Streets	7.3	7.2	7.0	7.1
40	New Rutherford/C-L @ Bunker Hill College	5.8	6.1	5.8	5.8
41	New Rutherford & Gilmore Bridge	5.9	5.5	5.5	5.5
42	New Rutherford/BS & G	6.0	5.7	5.7	5.3
43	Lechmere Square	5.0	4.9	4.9	5.0
44	Nashua Street and Martha Rd.	7.1	7.0	6.3	7.1
45	Cambridge St. & New Chardon	7.1	6.6	6.5	6.6
46	Cambridge St. & New Sudbury	7.3	6.7	6.6	6.7
47	Charles Circle	5.9	5.9	5.9	5.9
48	Broadway & 3rd Street	3.8	3.7	3.8	3.8
49	Sullivan Square	5.3	4.9	5.0	5.0

1. Eight-hour AAQS for carbon monoxide = 9 ppm
2. Values include 8-hour CO background level of 2.6 ppm
3. Analysis sites numbered 1 to 34 coincide with the numbering utilized in the 1990 SFEIS/R, sites 40 to 49 are new sites.

Source: Bechtel/Parsons Brinckerhoff

In summary, for the year 2001 all three alternatives result in beneficial effects when compared to Scheme Z, with no significant difference between alternatives. For the year 2010 when the roadway system is closer to capacity, the Reduced River-Tunnel and the Non-River-Tunnel have beneficial effects compared to Scheme Z, while 8.1D Mod. 5 results in very similar CO levels to those with Scheme Z.

6.2 MESOSCALE ANALYSIS

The total quantities of motor vehicle-related pollutants emitted in the study area was estimated to assess the change in "pollutant burdens". These changes in pollutant burdens (i.e., the tons of pollutants emitted each day) provide an indication of the general change in air quality in the region, and are useful in assessing relative changes in the levels of CO, VOCs, NO_x, PM₁₀ and O₃.

The emissions generated under the three alternatives were compared to those generated under the approved Proposed Action (Scheme Z) for the years 2001 and 2010, and to those generated in the 1990 base year. This information was used to determine the conformity of each alternative with the 1990 CAAA and the MSIP.

6.2.1 STUDY AREAS

The extent of the study area is the same as the one described in the 1991 FSEIS/R. All major highways, roadways and local streets within the study area are included in this assessment. In order to evaluate project impacts in the primary neighborhoods in Boston, six major geographic zones within the overall network are considered individually: Area North of Causeway, Central Area, I-93/I-90 Interchange, South Boston, East Boston, and East Cambridge (Fig. 2-3).

6.2.2 TRAFFIC DATA

Vehicle miles travelled (VMT), vehicle hours travelled (VHT), average travel speed, and vehicle classification for the different roadways were estimated for each of the six major geographic zones as part of the overall project traffic analysis. Average vehicular speeds were obtained by dividing VMT by VHT.

All the traffic data for the three alternatives and Scheme Z for the years 2001 and 2010 was based on predictions from the most current network in the TRANPLAN model. This network incorporates all the changes that have occurred since the publication of the 1991 FSEIS/R. This ensures that traffic differences for each of the four scenarios are due to design differences and not for other reasons, such as different base networks.

The traffic data for the base year (1990) was based on the 1987 network as presented in the 1991 FSEIS/R. The small traffic growth that occurred between 1987 and 1990 did not warrant the development of a new 1990 network.

6.2.3 ESTIMATED BASELINE (1990) AREAWIDE EMISSIONS

Estimated peak daily and annual areawide emissions of CO, VOCs, NO_x and PM₁₀ are provided in Tables 6-6 and 6-7. The traffic data used to estimate this emission is provided in Table 6-8. Annual emissions are estimated by multiplying the peak daily emissions by 331 days, this factor takes into consideration the reduced traffic levels during weekends and holidays. The results indicate that approximately a total of 39,088 tons per year of CO, 4,114 tons per year of VOCs, 2,964 tons per

Table 6-6

**PEAK DAILY EMISSION BURDENS IN THE STUDY AREA
FOR THE YEAR 1990
(tons per day)**

Affected Zone	CO	VOC	NO _x	PM ₁₀
Area North of Causeway				
Highways and Ramps	8.71	1.10	1.05	0.22
Covered Highways	0.00	0.00	0.00	0.00
Local Streets	9.11	0.92	0.57	0.73
Central Area				
Highways and Ramps	10.25	1.30	1.27	0.26
Covered Highways	2.54	0.32	0.31	0.05
Local Streets	19.55	1.91	0.95	1.37
I-93/I-90 Interchange				
Highways and Ramps	7.24	0.92	0.92	0.19
Covered Highways	0.00	0.00	0.00	0.00
Local Streets	11.61	1.16	0.82	0.83
South Boston				
Highways and Ramps	0.00	0.00	0.00	0.00
Covered Highways	0.00	0.00	0.00	0.00
Local Streets	16.94	1.62	1.04	1.00
East Boston				
Highways and Ramps	2.09	0.27	0.28	0.06
Covered Highways	0.83	0.11	0.14	0.02
Local Streets	6.96	0.72	0.53	0.75
East Cambridge				
Highways and Ramps	0.00	0.00	0.00	0.00
Covered Highways	0.00	0.00	0.00	0.00
Local Streets	22.24	2.09	1.09	1.30
Local Street Subtotals	86.42	8.41	5.00	5.99
Hwys./Ramps/Cov. Hwys. Subtotals	31.67	4.01	3.96	0.80
Totals	118.09	12.43	8.95	6.79

Source: Bechtel/Parsons Brinckerhoff

Table 6-7

**ANNUAL EMISSION BURDENS IN THE STUDY AREA
FOR THE YEAR 1990
(tons per year)**

Affected Zone	CO	VOC	NO_x	PM₁₀
Area North of Causeway				
Highways and Ramps	2,883	363	349	73
Covered Highways	0	0	0	0
Local Streets	3,016	303	188	242
Central Area				
Highways and Ramps	3,394	429	418	87
Covered Highways	841	106	101	16
Local Streets	6,471	631	315	453
I-93/I-90 Interchange				
Highways and Ramps	2,398	305	305	64
Covered Highways	0	0	0	0
Local Streets	3,844	383	272	276
South Boston				
Highways and Ramps	0	0	0	0
Covered Highways	0	0	0	0
Local Streets	5,608	537	343	331
East Boston				
Highways and Ramps	693	89	92	19
Covered Highways	274	37	45	7
Local Streets	2,305	238	176	249
East Cambridge				
Highways and Ramps	0	0	0	0
Covered Highways	0	0	0	0
Local Streets	7,363	693	360	431
Local Streets Subtotals	28,607	2,785	1,653	1,981
Hwys./Ramps/Cov. Hwys. Subtotals	10,482	1,328	1,310	266
Totals	39,088	4,114	2,964	2,247

Source: Bechtel/Parsons Brinckerhoff

Table 6-8

**TRAFFIC PARAMETERS USED TO ESTIMATE
AREAWIDE EMISSION BURDENS FOR THE YEAR 1990**

Affected Area	Vehicle Miles Travelled Per Day	Vehicle Hours Travelled Per Day	Average Network Speed Per Day (mph)
Area North of Causeway			
Highways and Ramps	511,120	22,331	22.9
Covered Highways	0	0	0
Local Streets	241,966	20,558	11.8
Central Area			
Highways and Ramps	613,943	26,112	23.5
Covered Highways	148,541	6,519	22.8
Local Streets	452,731	45,251	10.0
I-93/I-90 Interchange			
Highways and Ramps	449,687	18,263	24.6
Covered Highways	0	0	0.0
Local Streets	275,741	25,911	10.6
South Boston			
Highways and Ramps	0	0	0.0
Covered Highways	0	0	0.0
Local Streets	330,792	39,054	8.5
East Boston			
Highways and Ramps	136,878	5,200	26.3
Covered Highways	66,270	1,914	34.6
Local Streets	249,275	14,998	16.6
East Cambridge			
Highways and Ramps	0	0	0
Covered Highways	0	0	0
Local Streets	431,344	51,925	8.3
Local Streets			
Subtotals	1,981,848	197,697	10.0
Hwys./Ramps/Cov.Hwys.			
Subtotals	1,926,438	80,338	24.0
Totals	3,908,286	278,035	14.1

Source: Bechtel/Parsons Brinckerhoff.

year of NO_x and 2,247 tons per year of PM₁₀ were emitted by motor vehicles using the roadway network in the study area in 1990. Of these totals approximately 73% of CO, 68% of VOCs, 56% of NO_x and 88% of PM₁₀ were emitted from motor vehicles using the local streets in the study area.

6.2.4 ESTIMATED FUTURE AREAWIDE EMISSIONS FOR 2001

Estimated peak daily and annual areawide emissions of CO, VOCs, NO_x and PM₁₀ for year 2001 are shown in Tables 6-9 and 6-10. The traffic parameters used to estimate these emissions are provided in Table 6-11. When compared to the 1990 levels, the estimated vehicle miles travelled for Scheme Z are expected to increase 22%, vehicle hours travelled are expected to increase 10% and average network speed is expected to improve 12%. The results indicate that for Scheme Z approximately 25,590 tons per year of CO, 2,070 tons per year of VOCs, 2,300 tons per year of NO_x and 2,374 tons per year of PM₁₀ would be emitted by motor vehicles using the roadway network in the study area. Of these totals approximately 68% of CO, 64% of VOCs, 48% of NO_x and 87% of PM₁₀ will be emitted by vehicles traveling in the local streets on the study area.

Pollutant emission levels with Scheme Z in 2001 are estimated to result in a reduction of 34% in CO, 50% in VOCs and 22% in NO_x compared to the 1990 emission levels. In the case of PM₁₀, a 5% increase is anticipated. The reductions in CO, VOC's and NO_x emissions are due to the expected cleaner vehicles in the future as mandated by Federal and State regulations. In the case of PM₁₀, most of the emissions are due to roadway dust that is re-suspended by vehicle movement, as a consequence, the effect of cleaner vehicles has minimal impact toward emission reductions.

6.2.5 ESTIMATED FUTURE AREAWIDE EMISSIONS FOR 2010

Estimated peak daily and annual areawide emissions of CO, VOCs, NO_x and PM₁₀ for year 2010 are shown in Tables 6-12 and 6-13. The traffic parameters used to estimate these emissions are provided in Table 6-14. When compared to the 1990 levels, the estimated vehicle miles travelled for Scheme Z are expected to increase 40%, vehicle hours travelled are expected to increase 45% and average network speed is expected to decrease 3%. The results indicate that for Scheme Z approximately 31,627 tons per year of CO, 2,231 tons per year of VOCs, 2,454 tons per year of NO_x and 2,699 tons per year of PM₁₀ would be emitted by motor vehicles using the roadway network in the study area. Of these totals approximately 67% of CO, 65% of VOCs, 49% of NO_x and 86% of PM₁₀ will be emitted by vehicles traveling in the local streets on the study area.

When Scheme Z for the year 2010 is compared to the 1990 emission levels, the results indicate a reduction of 19% in CO, 45% in VOCs and 17% in NO_x. In the case of PM₁₀, a 20% increase is anticipated.

6.2.6 COMPARISON OF ALTERNATIVES

The estimated emissions for each one of the three proposed alternatives are slightly lower than the emissions estimated for Scheme Z, as a consequence all of them have marginal benefits when compared to Scheme Z (these reductions are in the order of one to two percent). When the new alternatives are compared to each other, the emission differences for all pollutants analyzed are within one percent.

It can be concluded that on an areawide basis, the three new design alternatives have no significant difference in emission levels for either year of analysis.

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Table 6-9
PEAK DAILY EMISSION BURDENS IN THE STUDY AREA
FOR THE YEAR 2001
(tons per day)

C O				V O C				N O x				P M 1 0				
AFFECTED ZONE	Scheme Z		Non- River- Tunnel	Reduced River- Tunnel	Scheme Z		Non- River- Tunnel	Reduced River- Tunnel	Scheme Z		Non- River- Tunnel	Reduced River- Tunnel	Scheme Z		Non- River- Tunnel	Reduced River- Tunnel
	8.1DMODS	8.1DMODS			8.1DMODS	8.1DMODS			8.1DMODS	8.1DMODS			8.1DMODS	8.1DMODS		
<u>Area North of Causeway</u>	4.97	4.69	5.75	4.61	0.46	0.42	0.50	0.43	0.78	0.66	0.77	0.71	0.23	0.19	0.22	0.20
Highways and Ramps																
Covered Highways	0.77	1.44	1.08	1.14	0.08	0.14	0.10	0.11	0.15	0.25	0.17	0.20	0.03	0.05	0.04	0.04
Local Streets	4.77	4.39	4.26	4.40	0.36	0.33	0.32	0.33	0.37	0.33	0.32	0.33	0.77	0.67	0.67	0.67
<u>Central Area</u>																
Highways and Ramps	4.73	4.79	4.67	4.69	0.42	0.42	0.42	0.42	0.66	0.66	0.66	0.66	0.19	0.19	0.19	0.19
Covered Highways	2.72	3.14	2.99	2.93	0.27	0.30	0.29	0.28	0.48	0.51	0.51	0.51	0.10	0.10	0.10	0.10
Local Streets	12.11	11.73	11.68	11.71	0.91	0.88	0.88	0.88	0.70	0.68	0.68	0.68	1.51	1.47	1.47	1.47
<u>I-93/I-90 Interchange</u>																
Highways and Ramps	6.58	6.03	6.10	6.07	0.53	0.50	0.50	0.50	0.70	0.70	0.70	0.71	0.20	0.20	0.20	0.20
Covered Highways	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Local Streets	8.26	8.35	8.26	8.39	0.65	0.66	0.65	0.66	0.61	0.61	0.61	0.61	0.99	1.00	0.99	0.99
<u>South Boston</u>																
Highways and Ramps	0.50	0.49	0.50	0.50	0.04	0.04	0.04	0.04	0.07	0.07	0.07	0.07	0.02	0.02	0.02	0.02
Covered Highways	1.33	1.30	1.30	1.30	0.14	0.14	0.14	0.14	0.29	0.29	0.29	0.29	0.06	0.06	0.06	0.06
Local Streets	9.75	9.80	9.82	9.78	0.77	0.77	0.77	0.77	0.66	0.66	0.66	0.66	1.02	1.03	1.03	1.03
<u>East Boston</u>																
Highways and Ramps	2.17	2.22	2.19	2.18	0.20	0.20	0.20	0.20	0.34	0.34	0.34	0.34	0.10	0.10	0.10	0.10
Covered Highways	0.47	0.47	0.49	0.48	0.05	0.05	0.05	0.05	0.10	0.10	0.10	0.10	0.02	0.02	0.02	0.02
Local Streets	4.98	5.03	4.94	5.06	0.38	0.38	0.38	0.38	0.30	0.30	0.30	0.30	0.59	0.58	0.59	0.59
<u>East Cambridge</u>																
Highways and Ramps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Covered Highways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Local Streets	13.19	13.11	13.15	13.27	1.00	1.00	1.00	1.01	0.74	0.73	0.73	0.73	1.35	1.35	1.35	1.35
Local Street Subtotals	53.07	52.41	53.10	52.60	4.06	4.02	4.00	4.03	3.37	3.31	3.31	3.31	6.23	6.09	6.10	6.10
Hwys./Ramps/ Covered Hwys. Subtotals	24.24	24.58	25.06	23.91	2.19	2.21	2.24	2.17	3.58	3.59	3.61	3.59	0.94	0.94	0.95	0.94
Totals	77.31	76.99	77.17	76.50	6.26	6.23	6.24	6.21	6.95	6.90	6.92	6.90	7.17	7.02	7.05	7.04

Source: Bechtel/Parsons Brinckerhoff

Table 6-10
PEAK ANNUAL EMISSION BURDENS IN THE STUDY AREA
FOR THE YEAR 2001
(tons per year)

C O				V O C				N O x				P M 1 0				
AFFECTED ZONE	Scheme Z 8.1DMOD5		Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1DMOD5		Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1DMOD5		Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1DMOD5		Non-River-Tunnel	Reduced River-Tunnel
<u>Area North of Causeway</u>																
Highways and Ramps	1,646	1,552	1,902	1,525	139	166	141	260	220	253	236	75	63	73	68	
Covered Highways	254	476	357	377	46	34	37	50	84	57	68	10	17	12	14	
Local Streets	1,577	1,453	1,409	1,456	110	106	110	122	108	107	108	255	221	223	222	
<u>Central Area</u>																
Highways and Ramps	1,566	1,585	1,547	1,551	140	138	138	218	219	219	220	63	63	63	63	
Covered Highways	900	1,040	989	969	98	95	94	159	170	169	167	32	35	34	34	
Local Streets	4,009	3,882	3,865	3,875	291	290	291	232	225	225	226	498	486	487	488	
<u>I-93/I-90 Interchange</u>																
Highways and Ramps	2,177	1,997	2,019	2,010	165	166	166	233	233	233	233	67	67	67	67	
Covered Highways	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	
Local Streets	2,736	2,763	2,736	2,776	219	216	220	202	203	202	203	328	330	328	329	
<u>South Boston</u>																
Highways and Ramps	166	163	165	165	14	14	14	22	22	22	22	6	6	6	6	
Covered Highways	441	430	430	431	46	46	46	97	95	95	95	19	19	19	19	
Local Streets	3,227	3,245	3,249	3,236	255	255	254	217	218	219	218	338	340	341	339	
<u>East Boston</u>																
Highways and Ramps	717	735	723	721	68	67	67	111	112	112	111	32	32	32	32	
Covered Highways	156	156	162	160	17	17	17	34	35	34	34	7	7	7	7	
Local Streets	1,649	1,664	1,635	1,674	126	124	127	99	98	98	99	194	193	194	195	
<u>East Cambridge</u>																
Highways and Ramps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Covered Highways	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Local Streets	4,368	4,340	4,353	4,392	329	330	334	243	242	243	243	448	445	447	446	
Local Street Subtotals	17,565	17,347	17,247	17,409	1,330	1,322	1,335	1,115	1,094	1,094	1,096	2,062	2,015	2,020	2,019	
Hwys./Ramps/ Covered Hwys. Subtotals	8,025	8,137	8,296	7,913	733	743	720	1,185	1,190	1,196	1,187	312	310	314	310	
Totals	25,590	25,484	25,543	25,322	2,063	2,065	2,055	2,300	2,291	2,291	2,284	2,374	2,325	2,333	2,329	

Source: Bechtel/Parsons Brinckerhoff

Table 6-11

**TRAFFIC PARAMETERS USED TO ESTIMATE
AREAWIDE EMISSION BURDENS FOR THE YEAR 2001**

AFFECTED AREA	Vehicle Miles Travelled Per Day				Vehicle Hours Travelled Per Day				Average Daily Network Speed (mph)			
	Scheme Z	8.1DMOD5	Non-River Tunnel	River Tunnel	Scheme Z	8.1DMOD5	Non-River Tunnel	River Tunnel	Scheme Z	8.1DMOD5	Non-River Tunnel	River Tunnel
Area North of Causeway												
Highways and Ramps	594,619	503,183	579,808	538,870	18,445	17,095	20,796	17,062	32.2	29.4	27.9	31.6
Covered Highways	112,307	190,868	131,261	153,343	2,952	5,433	4,015	4,321	38.0	35.1	32.7	35.5
Local Streets	259,098	224,491	227,257	225,945	15,953	15,385	14,492	15,378	16.2	14.6	15.7	14.7
Central Area												
Highways and Ramps	499,718	501,521	501,676	502,899	17,225	17,438	17,088	17,130	29.0	28.8	29.4	29.4
Covered Highways	363,070	388,547	384,001	380,397	10,298	11,738	11,229	11,012	35.3	33.1	34.2	34.5
Local Streets	506,850	493,904	494,977	496,186	47,647	45,977	45,913	46,052	10.6	10.7	10.8	10.8
I-93/I-90 Interchange												
Highways and Ramps	533,224	533,360	534,002	534,215	23,106	21,432	21,620	21,583	23.1	24.9	24.7	24.8
Covered Highways	889	895	902	902	26	26	26	26	34.2	33.9	34.2	34.2
Local Streets	334,088	335,372	333,966	334,480	33,200	33,552	33,037	33,782	10.1	10.0	10.1	9.9
South Boston												
Highways and Ramps	50,906	50,381	50,827	50,666	1,816	1,788	1,803	1,800	28.0	28.2	28.2	28.1
Covered Highways	215,303	211,269	211,399	211,869	5,216	5,090	5,091	5,105	41.3	41.5	41.5	41.5
Local Streets	344,288	346,179	346,591	345,219	41,624	41,782	41,587	41,564	8.3	8.3	8.3	8.3
East Boston												
Highways and Ramps	254,169	255,841	255,589	254,854	8,021	8,198	8,091	8,062	31.7	31.2	31.6	31.6
Covered Highways	75,560	76,770	77,103	76,638	1,843	1,844	1,907	1,884	41.0	41.6	40.4	40.7
Local Streets	197,709	196,723	197,483	197,876	20,137	20,482	19,960	20,658	9.8	9.6	9.9	9.6
East Cambridge												
Highways and Ramps	0	0	0	0	0	0	0	0	0	0	0	0
Covered Highways	0	0	0	0	0	0	0	0	0	0	0	0
Local Streets	455,895	453,060	454,357	453,929	57,103	56,944	57,125	57,258	8.0	8.0	8.0	7.9
Local Streets Subtotals	2,097,928	2,049,729	2,054,631	2,053,634	215,665	214,123	212,115	214,693	9.7	9.6	9.7	9.6
Hyws./Ramps/ Cov. Hwys. Subtotals	2,699,765	2,712,636	2,726,566	2,704,652	88,947	90,083	91,666	87,986	30.4	30.1	29.7	30.7
Totals	4,797,693	4,762,365	4,781,197	4,758,286	304,612	304,206	303,781	302,678	15.8	15.7	15.7	15.7

Table 6-12

C O				V O C				N O x				P M 1 0				
AFFECTED ZONE	Scheme Z 8.1D MOD5		Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1D MOD5		Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1D MOD5		Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1D MOD5		Non-River-Tunnel	Reduced River-Tunnel
	Scheme Z 8.1D MOD5	Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1D MOD5	Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1D MOD5	Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1D MOD5	Non-River-Tunnel	Reduced River-Tunnel	Scheme Z 8.1D MOD5	Non-River-Tunnel	Reduced River-Tunnel	
<u>Area North of Causeway</u> Highways and Ramps Covered Highways Local Streets	6.70	6.23	7.55	6.48	0.51	0.46	0.54	0.48	0.84	0.70	0.82	0.75	0.26	0.22	0.25	0.24
	1.08	1.81	1.54	1.70	0.09	0.15	0.12	0.13	0.16	0.27	0.18	0.21	0.04	0.06	0.04	0.05
	5.56	5.13	5.10	5.15	0.37	0.34	0.34	0.35	0.39	0.35	0.35	0.35	0.88	0.77	0.77	0.77
<u>Central Area</u> Highways and Ramps Covered Highways Local Streets	6.09	6.46	6.09	6.15	0.45	0.47	0.45	0.46	0.71	0.71	0.71	0.71	0.22	0.22	0.22	0.22
	3.74	3.99	4.00	3.99	0.29	0.31	0.31	0.31	0.50	0.53	0.53	0.52	0.11	0.12	0.12	0.12
	15.80	14.78	15.04	15.09	1.04	0.98	0.99	1.00	0.78	0.75	0.76	0.76	1.74	1.68	1.69	1.70
<u>I-93/I-90 Interchange</u> Highways and Ramps Covered Highways Local Streets	7.59	7.50	7.68	7.67	0.52	0.52	0.53	0.53	0.72	0.72	0.72	0.72	0.22	0.22	0.23	0.22
	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10.38	10.10	10.12	10.15	0.73	0.71	0.71	0.71	0.65	0.64	0.64	0.65	1.11	1.10	1.10	1.10
<u>South Boston</u> Highways and Ramps Covered Highways Local Streets	0.76	0.74	0.74	0.73	0.05	0.05	0.05	0.05	0.07	0.07	0.07	0.07	0.02	0.02	0.02	0.02
	1.86	1.77	1.78	1.78	0.16	0.16	0.16	0.16	0.32	0.31	0.31	0.31	0.07	0.07	0.07	0.07
	10.82	10.81	10.70	10.81	0.76	0.76	0.75	0.76	0.68	0.68	0.68	0.68	1.17	1.15	1.16	1.16
<u>East Boston</u> Highways and Ramps Covered Highways Local Streets	2.84	2.77	2.90	2.95	0.22	0.22	0.22	0.23	0.37	0.37	0.37	0.37	0.12	0.12	0.12	0.12
	0.57	0.56	0.56	0.55	0.05	0.05	0.05	0.05	0.11	0.11	0.11	0.11	0.02	0.02	0.02	0.02
	6.01	5.72	5.85	5.85	0.40	0.38	0.39	0.39	0.32	0.31	0.32	0.32	0.67	0.66	0.66	0.67
<u>East Cambridge</u> Highways and Ramps Covered Highways Local Streets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15.74	15.26	15.64	15.59	1.07	1.03	1.06	1.06	0.78	0.77	0.77	0.77	1.51	1.50	1.50	1.49
Local Street Subtotals	64.32	61.79	62.45	62.65	4.38	4.20	4.26	4.27	3.61	3.50	3.52	3.53	7.06	6.84	6.89	6.90
Hwys./Ramps/ Covered Hwys. Subtotals	31.23	31.83	32.84	32.02	2.36	2.38	2.44	2.39	3.80	3.79	3.82	3.78	1.09	1.08	1.09	1.08
Totals	95.55	93.62	95.29	94.67	6.74	6.59	6.69	6.66	7.41	7.29	7.35	7.31	8.16	7.92	7.98	7.98

Table 6-13

Source: Bechtel/Parsons Brinckerhoff

Bechtel/Parsons Brinckerhoff

Table 6-14

**TRAFFIC PARAMETERS USED TO ESTIMATE
AREAWIDE EMISSION BURDENS FOR THE YEAR 2010**

AFFECTED AREA	Vehicle Miles Travelled Per Day				Vehicle Hours Travelled Per Day				Average Daily Network Speed (mph)			
	<u>Scheme Z</u>	<u>8.1DMOD5</u>	<u>Non-River Tunnel</u>	<u>River Tunnel</u>	<u>Scheme Z</u>	<u>8.1DMOD5</u>	<u>Non-River Tunnel</u>	<u>River Tunnel</u>	<u>Scheme Z</u>	<u>8.1DMOD5</u>	<u>Non-River Tunnel</u>	<u>River Tunnel</u>
Area North of Causeway												
Highways and Ramps	696,855	578,091	668,161	618,692	24,885	22,674	27,264	23,707	28.0	25.5	24.5	26.1
Covered Highways	130,097	220,482	150,663	176,424	4,122	6,923	5,642	6,317	31.6	31.8	26.7	27.9
Local Streets	295,391	257,952	260,248	260,565	20,125	19,210	19,049	19,304	14.7	13.4	13.7	13.5
Central Area												
Highways and Ramps	583,591	582,859	584,304	584,840	22,267	23,440	22,318	22,493	26.2	24.9	26.2	26.0
Covered Highways	412,811	438,829	433,974	430,809	14,043	14,959	14,982	14,899	29.4	29.3	29.0	28.9
Local Streets	585,227	565,027	570,316	572,210	70,282	65,220	66,582	66,556	8.3	8.7	8.6	8.6
I-93/I-90 Interchange												
Highways and Ramps	591,785	590,571	592,269	591,604	26,930	26,606	27,172	27,095	22.0	22.2	21.8	21.8
Covered Highways	1,062	1,048	1,062	1,062	31	31	31	31	33.9	33.8	33.9	33.9
Local Streets	372,913	369,065	370,033	371,022	46,934	45,353	45,841	45,751	7.9	8.1	8.1	8.1
South Boston												
Highways and Ramps	61,181	61,077	61,140	61,109	2,713	2,645	2,633	2,628	22.5	23.1	23.2	23.3
Covered Highways	260,332	255,925	256,152	256,169	7,308	7,010	7,060	7,051	35.6	36.5	36.3	36.3
Local Streets	392,544	388,186	391,195	392,113	49,247	49,024	48,558	48,901	8.0	7.9	8.1	8.0
East Boston												
Highways and Ramps	306,577	304,037	309,231	308,151	10,600	10,371	10,816	10,975	28.9	29.3	28.6	28.1
Covered Highways	86,390	87,521	87,659	87,519	2,277	2,251	2,248	2,243	37.9	38.9	39.0	39.0
Local Streets	224,534	220,713	223,828	223,908	26,886	24,945	25,591	25,633	8.4	8.8	8.7	8.7
East Cambridge												
Highways and Ramps	0	0	0	0	0	0	0	0	0	0	0	0
Covered Highways	0	0	0	0	0	0	0	0	0	0	0	0
Local Streets	507,732	503,619	504,218	502,722	74,505	72,418	74,089	73,614	6.8	7.0	6.8	6.8
Local Streets Subtotals	2,378,342	2,304,562	2,319,838	2,322,539	287,979	276,170	279,710	279,759	8.3	8.3	8.3	8.3
Hyws./Ramps/ Cov. Hwys. Subtotals	3,130,681	3,120,440	3,144,614	3,116,379	115,176	116,910	120,166	117,439	27.2	26.7	26.2	26.5
Totals	5,509,023	5,425,002	5,464,452	5,438,918	403,155	393,081	399,876	397,198	13.7	13.8	13.7	13.7

7.0 VENTILATION BUILDING EMISSION ANALYSIS

7.1 METHODOLOGY

Analytical modeling was performed to evaluate potential impacts of CO, NO_x and PM₁₀ due to emissions from ventilation buildings associated with the proposed three new design Charles River Crossing alternatives. A detailed description of the analytical modeling is presented in Section 7.2. Results from the analytical modeling were used directly to perform the comparisons between the three new design alternatives.

The applicable AAQS and air quality guidelines have been presented in Section 3.1. Existing ambient air pollution levels have been presented in Section 4. The applicable background levels and methodology for compliance demonstration are discussed below.

7.1.1 ANNUAL NO₂ AND PM₁₀ AAQS

Annual average NO₂ impacts were estimated by assuming total (100%) conversion of NO_x emissions from the ventilation buildings, into NO₂. Modeled maximum annual NO₂ concentrations, were added to the appropriate background level and then compared to the corresponding AAQS for impact assessment.

Similarly, the highest calculated annual PM₁₀ concentrations when added to the appropriate background level were compared with the corresponding AAQS for impact assessment.

7.1.2 SHORT-TERM CO AND PM₁₀ AAQS

The EPA defines a violation of the AAQS as more than one exceedance per year of the short-term standard. Therefore, the highest second-highest modeled 1- and 8-hour CO concentrations and the highest second-highest 24-hour PM₁₀ concentrations, resulting from ventilation building emissions, were added to the highest appropriate background value and then compared to the corresponding AAQS for impact assessment.

7.1.3 MDEP 1-HOUR NO₂ POLICY GUIDELINE

Compliance with the MDEP 1-hour NO₂ guideline requires that:

- operation of the ventilation buildings will not increase the 1-hour NO₂ ambient concentration by more than 32 µg/m³ on more than one day per year, or
- operation of the ventilation buildings will not increase the 1-hour NO₂ ambient concentration such that, when the existing background concentration added to the new concentration, exceeds 320 µg/m³ on more than one day per year.

The 1-Hour NO₂ impacts were evaluated by converting the highest second-highest calculated NO_x concentrations into NO₂ concentrations using the Ozone Limiting Method (OLM) and then compared to the above guidelines for impact assessment.

7.1.4 OZONE LIMITING METHOD (OLM)

Most of the NO_x emitted by motor vehicles is in the form of NO. This NO is then converted to NO_2 via reactions in the atmosphere with other oxidants, mainly O_3 . In this DSEIS/R, it is assumed that the NO_2 present in the atmosphere (in the Boston area) results from three different sources.

- NO_2 emitted directly from the vehicles and released into the atmosphere through the ventilation building(s),
- NO_2 formed by oxidation of NO emitted from the vehicles and released into the atmosphere through the ventilation building(s), and
- Background NO_2 present in the atmosphere.

The OLM was used to account for the conversion of NO into NO_2 , and the maximum overall conversion rate is 81%. This maximum conversion methodology was developed and approved in the 1991 FSEIS/R.

The OLM was applied as follows:

If $\text{O}_3_{(b)} > 0.76 \text{NO}_{x(I)}$, then

$$\begin{aligned}\text{NO}_2 &= 0.05 \text{NO}_{x(I)} + 0.76 \text{NO}_{x(I)} + \text{NO}_{2(b)} \\ &= 0.81 \text{NO}_{x(I)} + \text{NO}_{2(b)}\end{aligned}$$

otherwise,

$$\text{NO}_2 = 0.05 \text{NO}_{x(I)} + \text{O}_{3(b)} + \text{NO}_{2(b)}.$$

Notes:

Subscripts (b) and (I) denote background and modeled values respectively.

The constant (0.05), represents the fraction of NO_x directly emitted from vehicles as NO_2 via thermal conversion.

The constant (0.76) represents the fraction of NO emitted from vehicles which is converted to NO_2 via oxidation.

7.1.5 BACKGROUND DETERMINATION

Background concentrations are those which result from emissions not accounted by the analytical modeling. In this DSEIS/R, CO impacts from both surface traffic (Mobile Source Analysis) and tunnel traffic (Ventilation Building Analysis) have been modeled. For NO_2 and PM_{10} impacts, only the Ventilation Building Analysis is required.

Background concentrations of the pollutants assessed herein were based on data collected by MDEP. These data were used to determine the highest background concentrations for use in this DSEIS/R.

Background CO Levels. The background CO concentrations used in the ventilation building emission analysis have been developed in the Mobile Source Analysis described in Section 6.1.6. Background CO levels are shown in Table 6-1.

Background NO₂ And O₃ Levels. No background NO₂ concentrations have been measured in the vicinity of the area north of Causeway Street. Background NO₂ and O₃ data required by this analysis were derived from the same two MDEP air quality stations at Bremen Street in East Boston and at Chelsea, as in the 1991 FSEIS/R.

Background NO₂ concentrations collected at the Bremen Street site are expected to be higher than those at the Charles River Crossing area due to emissions associated with Logan Airport aircraft and the local motor vehicle traffic. Therefore, the use of the measured NO₂ concentrations from Bremen Street yield conservative total NO₂ estimates. The total estimates (concentrations) include contributions from the proposed ventilation buildings as well as the background concentrations in the area. The highest annual average NO₂ concentrations at Bremen Street for the period 1989 to 1991 was 60 µg/m³. This value was used in the impact assessment.

As stated in Section 7.1.3, 1-Hour NO₂ impacts were evaluated using the OLM. This method required the use of concurrent NO₂ and O₃ background data. As mentioned above, the MDEP Chelsea Air Quality Monitoring Station was used to estimate the required O₃ background concentrations. This is the closest station to the proposed Charles River Crossing area and was assumed to represent ambient O₃ levels in the area.

Background values of NO₂ and O₃ were provided as 1-hour averages for every hour of the year, for the period 1985 to 1989. The reason for using background NO₂ and O₃ data for the period 1985 to 1989 is to match the same time period of the meteorological data used in the dispersion estimates. These values were used with the OLM to calculate the 1-hour average total NO₂ concentrations.

Background PM₁₀ Levels. The 24-hour and annual background PM₁₀ concentrations were determined from the MDEP One City Square Air Quality Monitoring Station. The three most recent available years, as shown in MDEP (1989 and 1990), and EPA (1991) were used. This station is the closest to the Charles River Crossing area.

The highest 24-hour concentrations at that site were 96 µg/m³ in 1990 and 68 µg/m³ in 1991. Note that the high background level in 1990 was affected by heavy construction activities at the CANA ramp in that year. When this background value (96 µg/m³) was added to the highest second-highest 24-hour PM₁₀ modeled concentration, the total yields a conservative estimate for impact assessment.

The highest annual concentrations at One City Square was 38 µg/m³ in 1990. This background value was used for impact assessment.

7.2 ANALYTICAL DISPERSION MODELING

Analytical dispersion modeling was performed to evaluate potential CO, NO_x, and PM₁₀ impacts due to vehicle emissions in the tunnel released through the proposed ventilation buildings. The analysis were based on current ventilation building design as documented in this DSEIS/R.

As described in the 1991 FSEIS/R, the EPA-approved Industrial Source Complex Short-Term (ISCST2) Dispersion Model was used to perform the analytical modeling. The ISCST2 model has



FIGURE 7.1
Ventilation Building No.8 And
Nearby Major Structures:
Alternative 8.1D Mod 5
Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
CENTRAL ARTERY /TUNNEL PROJECT



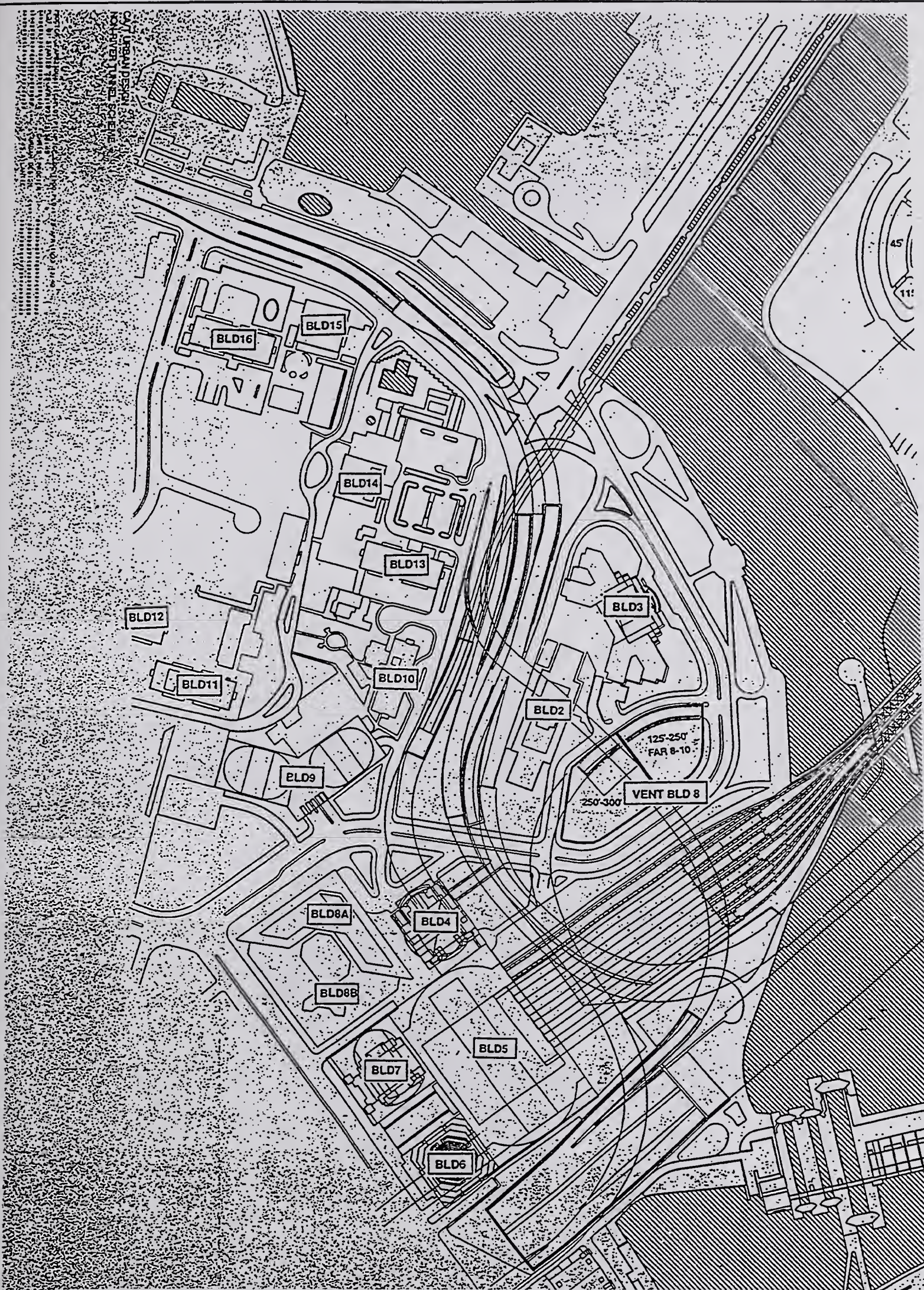


FIGURE 7.2 Ventilation Building No.8 And Nearby Major Structures: Non-River-Tunnel Alternative Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
CENTRAL ARTERY /TUNNEL PROJECT



1. The proposed ventilation building No. 8 and nearby major structures are shown on the map. The ventilation building No. 8 is located at the intersection of the Central Artery and the River Tunnel. The nearby major structures are located along the Central Artery and the River Tunnel.

2. The map shows the location of the ventilation building No. 8 and nearby major structures. The ventilation building No. 8 is located at the intersection of the Central Artery and the River Tunnel. The nearby major structures are located along the Central Artery and the River Tunnel.

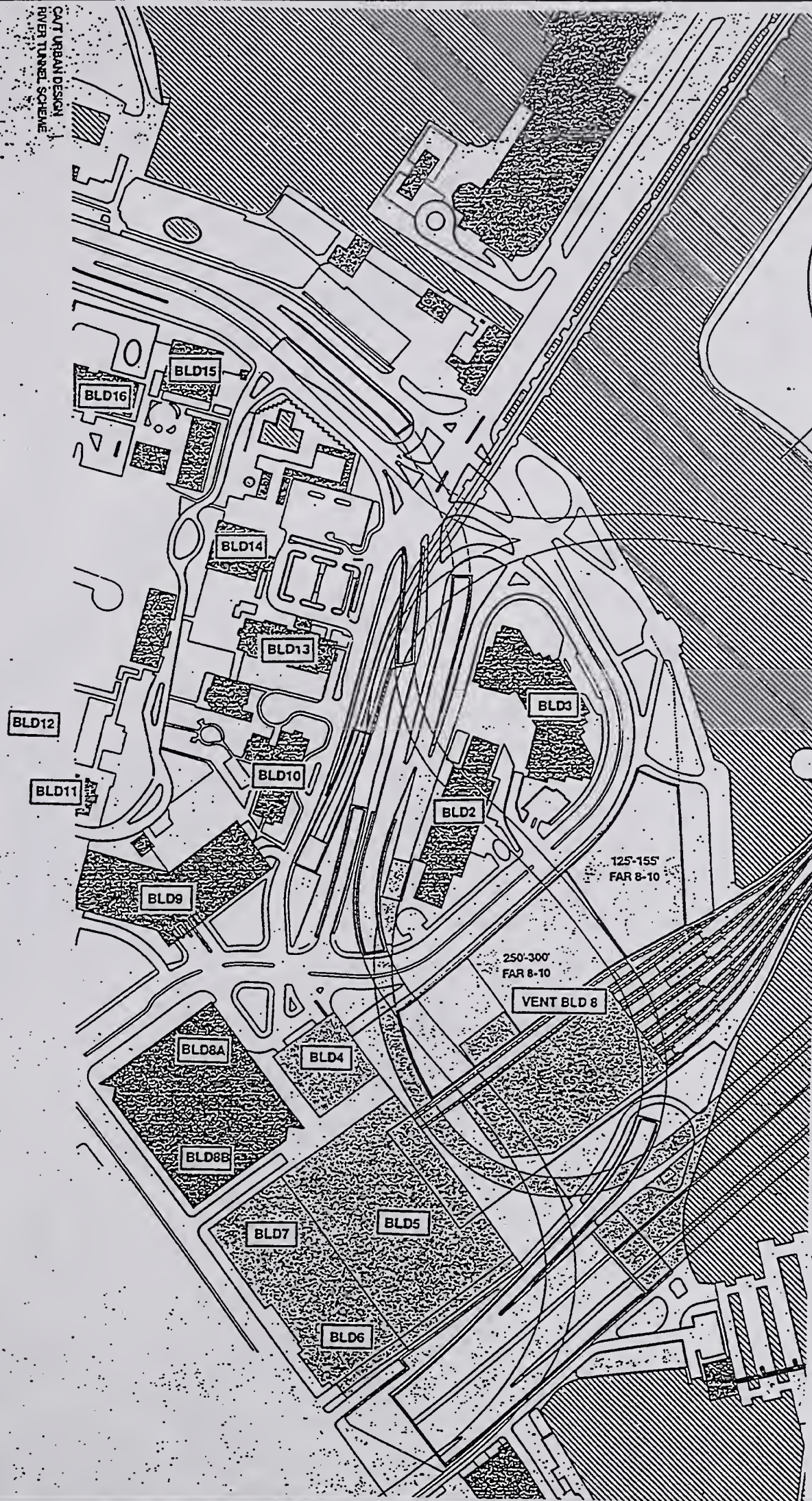


FIGURE 7.3 Ventilation Building No.8 And Nearby Major Structures: Reduced River-Tunnel Alternative Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
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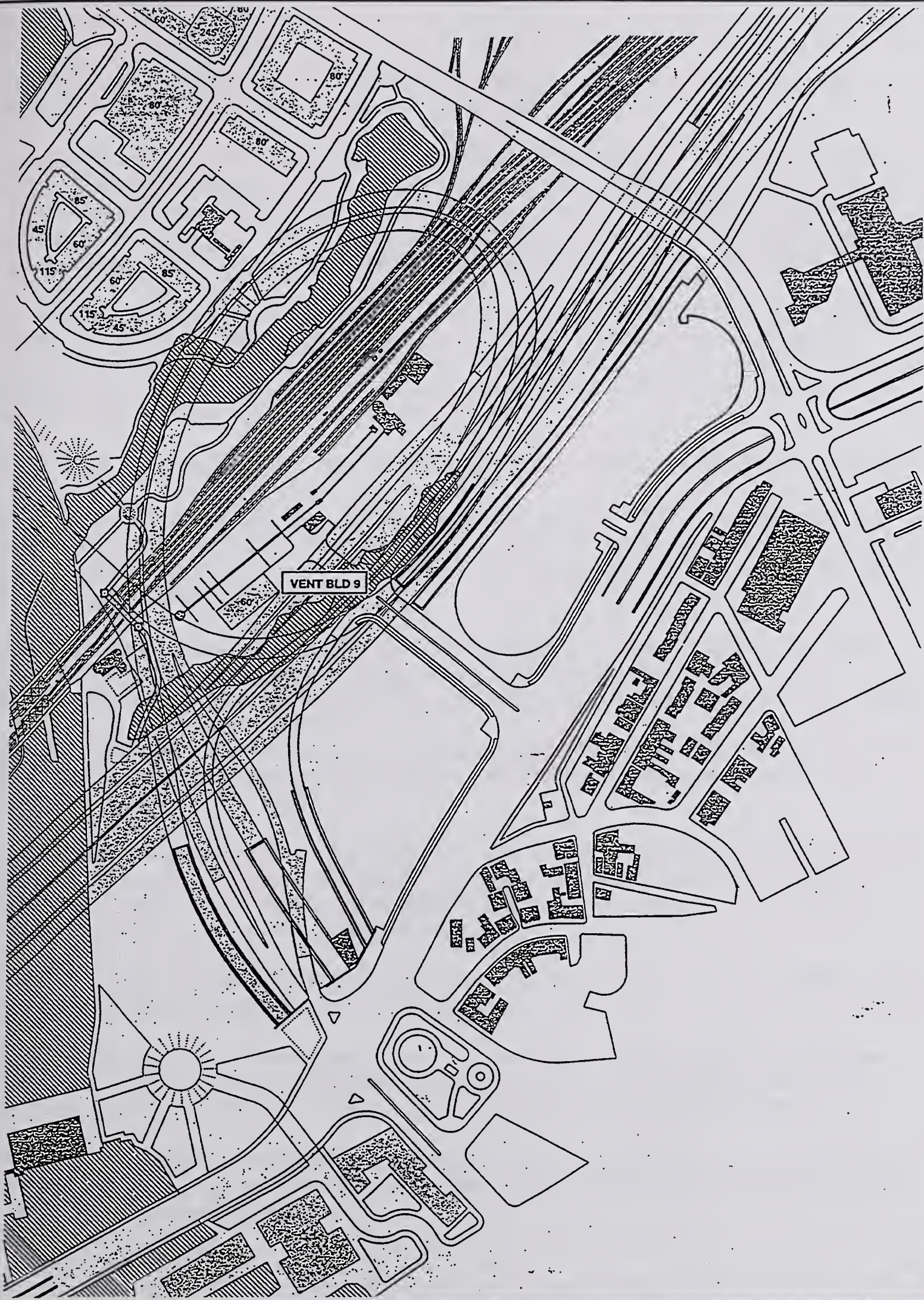


FIGURE
7.4

Ventilation Building No.9 And
Proposed Development In Cambridge:
Reduced River-Tunnel Alternative
Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
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been revised by the EPA since the 1991 FSEIS/R was issued; therefore, the most recent version (EPA-450/4-92-008, September 1992) was used in this study.

As stated in Section 1.0, the resulting impacts of these design alternatives were expected to comply with all the applicable regulations. Consequently, the underlying objective of the modeling study was to determine the lowest possible stack height for which no violation of an applicable AAQS would be expected to occur, for each of the three new design alternatives. The methodology employed to make this determination, as well as the results obtained, are discussed in detail in the following sections.

Stack heights found to be in compliance by the EPA SCREEN model (Version 88300), (EPA, 1988) were used in the detailed dispersion analysis. The resulting concentrations from the detailed dispersion analysis were used for impact assessment in order to decide if the vent height was in compliance for all receptor locations. If a violation was found, the vent height was increased and the process repeated until a compliance vent height was found.

7.2.1 GEP STACK HEIGHT DETERMINATION AND DOWNWASH PARAMETERS

To gauge the stack heights, the Good Engineering Practice (GEP) stack height was determined according to guidance contained in *Guideline for Determination of Good Engineering Practice Stack Height, Technical Support Document for the Stack Height Regulations*, (EPA, 1985), along with the accompanying downwash parameters.

Downwash is the process by which plume dispersion is affected by building-induced perturbed air flow. Downwash lowers the plume centerline causing higher concentrations at ground-level. Downwash parameters are a necessary ISCST2 model input when emissions occur below GEP height.

Buildings Analyzed. Plot and building plans indicating length, width, and height of the ventilation building(s), and nearby existing and future structures, which may cause plume downwash, were evaluated.

In those areas designated for future development, the effective horizontal dimensions of the structures (from a wake effect standpoint) were assumed to cover the entire area available on the current, undeveloped parcel of land. The vertical dimensions of these structures were assumed to be at the maximum height that zoning in the area would allow.

Structures analyzed are shown in (Figs, 7-1 through 7-4) for the three new design alternatives. A list of building names and dimensions is given in Table 7-1.

GEP Stack Height. Urban design plans were used to determine the distances between each of the buildings considered and the vent locations for a given alternative. These plans were also used to determine the maximum projected width possible for a specific building/vent combination.

From these parameters, the GEP vent height was determined for each of 36, 10° sectors around the ventilation building. The maximum of these calculated heights was designated as the controlling GEP stack height for a given alternative.

Table 7-1**BUILDING NOMENCLATURE AND HEIGHT**

No.	Building Name	Building Height (ft)
2	Registry of Motor Vehicles	168
3	Suffolk County Jail	80
4	Future Boston Garden Tower A	454
5	New Boston Gardens Building	162
5	Future Boston Garden Tower C	464
7	Future Boston Garden Tower A	376
8	Thomas P. O'Neill Federal Bldg.	125
9	Charles River Park Garage	55
10	Amy Lowell House (Sr. Citizens)	55
11	Longfellow Place Apartments	125
12	Longfellow Place Apartments	175
13	5, 6, and 7 Whittier Place	175
14	8 Whittier Place	175
15	10 Emerson Place Apartments	234
16	One Emerson Place Apartments	250

Source: Bechtel/Parsons Brinckerhoff

8.1D Mod.5

For this alternative, GEP stack heights were calculated for two separate vent locations for VB 8. However, because of their proximity, the calculation yielded identical results. The highest GEP stack height was calculated as 1,135' (346 m) for sectors 120°, 130°, 300°, and 310°. The controlling structures for these sectors were identified as the Future Boston Garden Towers A and C. These sectors are 180° out-of-phase, indicating that the zone of influence for the controlling structure encompassed the vent location for both the downwind and upwind flow vectors.

Reduced River-Tunnel

The design for this alternative includes two ventilation buildings, VB 8 and 9. The highest GEP stack height for VB 8 and 9 was calculated as 1,135' (346 m) for sectors 130° (VB 8 only) and 310° (VB 8 and VB 9). As in the 8.1D Mod.5 alternative, the controlling structures for these sectors were identified as Future Boston Garden Towers A and C.

Non-River-Tunnel

This alternative is designed with a single ventilation building, VB 8. The highest GEP stack height was again calculated as 1,135' (346 m) for sectors 130° and 310°. The controlling structures for these sectors were identified as Future Boston Garden Towers A and C.

Clearly, it is not practical to construct a ventilation stack to the GEP height of 1,135' in downtown Boston. Therefore, the iterative procedure discussed in following sections was used to determine a more realistic stack height based on an analysis of potential air quality impacts to the area surrounding the ventilation buildings.

Downwash Parameters. The procedure used to determine the GEP stack height also generated direction-specific building dimensions (length and maximum projected width) relative to each vent. These dimensions were input to the ISCST2 dispersion model to account for direction-dependent building downwash effects.

7.2.2 CAVITY CALCULATIONS

This section focuses on impacts within the area of disturbed air flow, nominally extending three building heights downwind of a structure, referred to as the "cavity region". Air flow within this region is characterized by re-circulation which, given a constant emission source, leads to relatively higher pollutant concentrations due to restricted dispersion.

A cavity analysis is necessary to evaluate concentrations at receptors close to the ventilation building for vent heights below GEP. Initially, using a trial-and-error approach, the lowest possible stack height, within compliance for all applicable AAQS was determined for each design alternative. The SCREEN model was used to perform the cavity analysis.

This analysis was selected as the first iteration of the stack height determination procedure because ground level impacts within the cavity region are often much greater (and therefore more limiting in terms of facility design) than impacts beyond it. Once the stack height was set based on the cavity analysis, the second iteration evaluated pollutant impacts beyond the cavity to ensure that the selected stack height was still in compliance with all the applicable AAQS (see Section 7.2.3).

Technical Approach. Numerous tall and massive structures surround the proposed ventilation building sites. The SCREEN model was used to estimate the vertical and downwind extent of the cavities created by these buildings and to determine whether the vent plumes would be caught within these regions.

Modeled concentration estimates within the cavity region for a given stack height were compared to either the 1-hour NO₂ significant impact level of 32 µg/m³ or the 1-hour total NO₂ level (i.e., including background) of 320 µg/m³ to demonstrate compliance. Stack heights in compliance within the cavity were then tested for compliance beyond the cavity, in the analytical modeling analysis (see Section 7.2.3).

Ventilation Building 8 - All Design Alternatives. The specific structures considered in this analysis represent a subset of the buildings evaluated in the GEP analysis. Those buildings whose maximum cavity height was less than the initial stack height for VB 8 (320 ft) were not considered further because the stack plume would not be caught in the cavity region. This initial stack height was set at the maximum height that zoning for the parcel to be developed would allow (300 ft), plus an arbitrary additional 20 ft.

For the remaining buildings, two different wind orientations were considered (which varies the cavity size) in order to bracket the expected range of concentrations within the cavity. These orientations do not represent the absolute maximum and minimum complimentary alongwind and crosswind building dimensions. Rather, they represent the actual maximum and minimum alongwind building dimensions, and the corresponding crosswind distances, taking into account the orientation of the structure relative to the proposed vent location.

Based on this information as well as the shortest distance between a given structure and the proposed vent location, a spreadsheet was developed using the building downwash procedures in Appendix A of the SCREEN model User's Guide (EPA, 1988) to determine if the resulting cavity would intercept the stack plume. The results of this evaluation are listed in Tables 7-2 through 7-4.

A series of concentration calculations were then made with the SCREEN model for each structure and group of structures whose individual or composite cavities could potentially intercept the plume. For VB 8, the composite structures included:

- the project area for proposed future development limited by zoning to a height of 155 or 250 ft in addition to the two areas listed below, to a height of 155 or 250 ft (155 ft for the Reduced River-Tunnel alternative, and 250 ft for the 8.1D Mod.5 and Non-River-Tunnel alternatives),
- the project area for proposed future development limited by zoning to a height of 300 ft in addition to the Future Boston Garden Tower A, to a height of 300 ft), and
- the area covered by the Future Boston Garden Tower A, which rises to a height of 454 ft.

Vent emission rates for each project alternative and other emission design parameters are shown in Tables 7-5 and 7-6, respectively.

As in the GEP analysis, the effective horizontal dimensions of the structures in the two areas proposed for future development were assumed to cover the entire area available on the current,

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Table 7-2

CAVITY HEIGHT AND LENGTH CALCULATIONS FOR EXISTING/PLANNED STRUCTURES NEAR VENTILATION BUILDING 8 FOR THE 8.1D MOD 5 ALTERNATIVE

Bldg ID & Orientation ^a	Bldg Ht (m)	Alongwind Dimension (m) ^b	Crosswind Dimension (m) ^b	L/Hb ^c	Cavity Length Short (m)	Cavity Length Long (m)	Cavity Height (m) ^d	Cavity Length (m)	Dist To Source (m)	Does Cavity Affect Stack ^e
2 - Minimum	51.2	31	111	0.61	181	0	89	181	114	NO
2 - Maximum		34	111	0.66	174	0	86	174		NO
4 - Minimum	138.4	50	59	0.36	169	0	277	169	202	NO
4 - Maximum		51	72	0.37	199	0	276	199		NO
5 - Minimum	49.4	91	143	1.84	113	0	57	113	201	NO
5 - Maximum		113	170	2.29	0	160	53	160		NO
6 - Minimum	141.5	53	62	0.37	173	0	281	173	313	NO
6 - Maximum		56	67	0.40	181	0	277	181		NO
7 - Minimum	114.6	55	61	0.48	147	0	213	147	294	NO
7 - Maximum		56	71	0.49	167	0	212	167		NO
8A - Minimum	38.1	90	104	2.36	0	108	41	108	261	NO
8A - Maximum		98	94	2.57	0	102	40	102		NO
12 - Minimum	38.1	67	27	1.76	27	0	44	27	426	NO
12 - Maximum		67	32	1.76	31	0	44	31		NO
13 - Minimum	53.4	56	53	1.05	76	0	75	76	247	NO
13 - Maximum		69	42	1.29	54	0	69	54		NO
14 - Minimum	53.4	37	43	0.69	81	0	88	81	324	NO
14 - Maximum		40	46	0.75	82	0	86	82		NO
15 - Minimum	71.3	59	46	0.58	99	0	125	99	432	NO
15 - Maximum		72	47	0.59	99	0	124	99		NO
16 - Minimum	76.2	58	55	0.76	100	0	122	100	456	NO
16 - Maximum		71	50	0.93	81	0	113	81		NO

Notes:

a - Building IDs correspond to the structures shown in Figs. 2-1 to 2-4 and listed in Table 7-1.

b - Represents the actual minimum and maximum alongwind building dimensions, and the corresponding crosswind distances, taking into account the orientation of the structure relative to the proposed vent location.

c - Represents the ratio of the respective alongwind building dimension to the building height to determine cavity length based on Equation A.11 for short buildings ($L/H_b < 2$) or Equation A.12 for long buildings ($L/H_b \geq 2$) after Hosker as given in EPA (1988, pp. A-36 and A-37).

d - Cavity height values are based on Equation A.9 after Hosker as given in EPA (1988, pp. A-35 and A-36).

e - Indicates if cavity region for a given structure and orientation intercepts the plume by meeting these criteria: cavity height $\geq$ initial vent height of 97.5 m (320 ft) and cavity length $\geq$ distance from indicated structure to VB 8.

Source: Bechtel/Parsons Brinckerhoff

Table 7-4

CAVITY HEIGHT AND LENGTH CALCULATIONS FOR EXISTING/PLANNED STRUCTURES NEAR VENTILATION BUILDING 8 FOR THE NON-RIVER-TUNNEL ALTERNATIVE

Bldg ID & Orientation ^a	Bldg Ht (m)	Alongwind Dimension (m) ^b	Crosswind Dimension (m) ^b	L/Hb ^c	Cavity Length Short (m)	Cavity Length Long (m)	Cavity Height (m) ^d	Cavity Length (m)	Dist To Source (m)	Does Cavity Affect Stack ^e
2 - Minimum	51.2	30	111	0.49	183	0	89	179		NO
2 - Maximum		32	116	0.53	184	0	88	177	42	NO
4 - Minimum	138.4	50	59	0.36	169	0	277	169		YES
4 - Maximum		50	70	0.36	196	0	277	196	151	YES
5 - Minimum	49.4	94	159	1.90	120	0	56	120		NO
5 - Maximum		148	161	3.00	0	155	51	155	163	NO
6 - Minimum	141.5	57	67	0.40	179	0	276	179		NO
6 - Maximum		65	71	0.46	177	0	266	177	286	NO
7 - Minimum	114.6	56	69	0.49	163	0	212	163		NO
7 - Maximum		61	79	0.53	175	0	206	175	252	NO
8A - Minimum	38.1	90	102	2.36	0	107	39	107		NO
8A - Maximum		95	98	2.49	0	104	38	104	172	NO
12 - Minimum	38.1	67	27	1.76	27	0	44	27		NO
12 - Maximum		67	33	1.76	32	0	44	32	348	NO
13 - Minimum	53.4	43	63	0.81	103	0	83	103		NO
13 - Maximum		67	50	1.25	64	0	70	64	184	NO
14 - Minimum	53.4	40	44	0.75	79	0	89	79		NO
14 - Maximum		44	47	0.82	79	0	88	79	263	NO
15 - Minimum	71.3	44	47	0.62	97	0	122	97		NO
15 - Maximum		47	47	0.66	93	0	120	93	372	NO
16 - Minimum	76.2	44	61	0.58	127	0	134	127		NO
16 - Maximum		56	55	0.73	102	0	123	102	396	NO

Notes:

a - Building IDs correspond to the structures shown in Figs. 2-1 to 2-4 and listed in Table 7-1.

b - Represents the actual minimum and maximum alongwind building dimensions, and the corresponding crosswind distances, taking into account the orientation of the structure relative to the proposed vent location.

c - Represents the ratio of the respective alongwind building dimension to the building height to determine cavity length based on Equation A.11 for short buildings ($L/Hb < 2$) or Equation A.12 for long buildings ($L/Hb \geq 2$) after Hosker as given in EPA (1988, pp. A-36 and A-37).

d - Cavity height values are based on Equation A.9 after Hosker as given in EPA (1988, pp. A-35 and A-36).

e - Indicates if cavity region for a given structure and orientation intercepts the plume by meeting these criteria: cavity height $\geq$ initial vent height of 97.5 m (320 ft) and cavity length $\geq$ distance from indicated structure to VB 8.

Source: Bechtel/Parsons Brinckerhoff

Table 7-5

VENTILATION BUILDING EMISSION RATES (g/s)

Bldg. No.	Alternative	CO 1-hour ¹	CO 8-hour ²	NO _x 1-hour	NO _x 8-hour	PM ₁₀ 8-hour
Year 2001						
1		5.738	4.263	0.753	0.533	
4		18.514	13.763	2.348	1.860	
4		25.757	14.742	2.624	1.915	
5		7.303	3.989	0.921	0.600	
5		6.049	2.945	0.761	0.444	
7		10.758	5.592	1.385	0.775	
8	8.1D Mod 5	12.344	9.192	1.646	1.279	
8	Non-River-Tunnel	2.899	2.213	0.405	0.321	
8	Reduced River-Tunnel	2.784	2.139	0.310	0.310	
9	Reduced River-Tunnel	2.999	2.286	0.484	0.372	
Year 2010						
1		6.809	5.517	0.788	0.658	0.226
3		27.010	16.984	2.630	2.000	0.694
4		37.887	18.479	3.041	2.095	0.728
5		9.803	6.030	0.999	0.770	0.294
6		8.470	5.276	0.860	0.647	0.250
7		14.258	9.564	1.481	1.156	0.416
8	8.1D Mod 5	16.328	10.316	1.834	1.353	0.299
8	Non-River-Tunnel	3.386	2.583	0.438	0.348	0.077
8	Reduced-River-Tunnel	3.519	2.540	0.482	0.343	0.077
9	Reduced River-Tunnel	4.122	2.758	0.526	0.393	0.088

Notes: ¹ Peak 1-hour emissions based on peak 1-hour traffic.

² Peak 8-hour emissions based on peak 8-hour traffic.

Source: Bechtel/Parsons Brinckerhoff

Table 7-6

VENTILATION BUILDING DESIGN PARAMETERS

Building No.	Alternative	Stack Height (m)	Exit Velocity (m/s)	Stack Effective Diameter (m)
8	8.1D Mod. 5 (aboveground)	100.6	7.62	6.86
8	Non-River Tunnel (underground)	100.6	7.62	5.22
8	Reduced-River Tunnel (underground)	97.5	7.62	5.42
9	Reduced-River Tunnel (aboveground)	32.0	7.62	5.32
1		41.1	8.13	10.07
3		73.2	8.13	13.08
4		38.1	8.13	13.70
5		38.9	8.13	12.38
6		27.7	8.13	8.64
7		32.7	8.13	13.20

Note: Vent effluent temperature assumed as ambient.

Building No.	Alternative	Width (m)	Length (m)	Height (m)
8	8.1D Mod. 5	33.6	38.4	18.3
9	Reduced River-Tunnel	12.6	34.2	18.3

undeveloped parcel of land. For conservatism, peak 1-hour NO_x emission rates for the year 2010, the highest of the two phases considered, were input to the SCREEN model.

The first step in this series of model runs was to make an "omni-directional" set of calculations for the 250 ft and 300 ft composite structures listed above, for the maximum and minimum alongwind dimensions. If these calculations showed that the expected range of cavity concentrations were less than $32 \mu\text{g}/\text{m}^3$ (i.e., significant impact level for NO_2), then a demonstration of compliance was considered to have been made for the particular structure being evaluated. However, if a cavity concentration was greater than the significant impact level, it became necessary to determine if the 1-hour NO_2 guideline value ($320 \mu\text{g}/\text{m}^3$) would be exceeded.

The second step involved combining the highest modeled "omni-directional" cavity concentration with the highest measured direction-specific background values for each of 36 10° -sectors. If the total concentration was found to be greater than the $320 \mu\text{g}/\text{m}^3$ guideline value for any sector, then a cavity calculation was made incorporating direction-specific alongwind and crosswind building dimensions.

In this case, compliance could still be demonstrated if either the revised total impact was less the guideline value or if an exceedance was still indicated, but the contribution due to ventilation building emissions was not significant (i.e., $< 32 \mu\text{g}/\text{m}^3$) for that direction. Failing this, the stack height was incrementally raised and the cavity concentrations re-calculated until a compliance demonstration was achieved. The overall process was then repeated for individual structures whose cavity was shown to intercept the vent plume.

Table 7-7 lists the three highest 1-hour NO_2 concentrations for the period 1985 to 1989, based on data collected by MDEP Bremen Street Air Quality Monitoring Station (see Section 7.1.5).

It should be noted that for the 110° -sector, the highest measured background NO_2 concentration is $376.28 \mu\text{g}/\text{m}^3$. This is the only 1-hour value to exceed the $320 \mu\text{g}/\text{m}^3$ guideline value at this station during the five-year measurement period. Consequently, direction-specific cavity calculations were always made for this sector, to test whether the stack height would provide an insignificant ground impact.

Ventilation Building 9 - Reduced-River-Tunnel Alternative. The Reduced River-Tunnel alternative includes a second ventilation building on the north side of the Charles River, referred to as VB 9. A similar iterative process was applied for estimating cavity concentrations associated with the tunnel vehicle emissions released through this building.

Compliance Stack Height Determination. Stack heights were determined based on the ability to show that impacts within the structural cavities affecting these buildings were either less than MDEP's 1-hour NO_2 significant impact level of $32 \mu\text{g}/\text{m}^3$ or the 1-hour guideline value of $320 \mu\text{g}/\text{m}^3$ (including background).

Alternative 8.1D Mod 5. As a first step, the cavity analyses showed that Buildings 2-16, (see Figure 7-1), did not affect emissions from VB 8 for 8.1D Mod 5. However, for VB 8, a stack of at least 330 ft (100.6 m) was determined to be necessary to demonstrate compliance with the applicable 1-hour NO_2 guideline values within the cavity region.

SCREEN model results for the 300 ft composite structure and an initial stack height of 320 ft (97.5 m) showed a total 1-hour average NO_2 impact of $320.94 \mu\text{g}/\text{m}^3$ for the 140° downwind sector; which is greater than the $320 \mu\text{g}/\text{m}^3$ guideline value. Emissions from VB 8 contributed significantly (38.73

Table 7-7
SECTOR-DEPENDENT BACKGROUND 1-HOUR NO₂ CONCENTRATIONS

Downwind Sector (Deg)	1st High (µg/m ³)	Julian Date (YYDDDHH)	2 nd High (µg/m ³)	Julian Date (YYDDDHH)	3 rd High (µg/m ³)	Julian Date (YYDDDHH)
10	169.33	8606308	169.33	8921522	167.44	8710422
20	203.19	8818620	197.55	8925221	197.55	8925222
30	191.90	8818621	186.26	8816523	150.51	8801210
40	197.55	8616621	186.26	8622220	165.56	8620421
50	214.48	8816522	178.73	8925223	174.97	8730818
60	176.85	8929820	165.56	8816620	159.92	8622219
70	173.09	8505317	158.04	8528218	154.27	8701422
80	163.68	8526223	148.63	8502520	146.75	8526305
90	163.68	8526219	150.51	8628809	141.10	8628912
100	193.78	8615022	144.07	8925323	188.14	8628911
110	376.28 b	8628909	301.02	8628610	150.51	8628917
120	216.36	8925322	186.23	8929821	173.09	8501506
130	263.40	8628923	186.26	8628924	163.68	8925324
140	282.21	8628922	206.95	8628920	174.97	8501504
150	235.18	8628921	148.63	8705401	139.22	8501509
160	188.14	8629006	163.68	8710501	159.92	8710502
170	225.77	8629007	182.50	8501515	183.14	8526305
180	199.43	8710506	159.92	8829507	158.04	8829508
190	244.58	8629008	195.67	8501502	195.67	8701005
200	212.60	8501501	174.97	8710508	148.63	8611020
210	220.12	8710507	210.72	8615020	152.39	8501423
220	144.87	8618621	126.05	8707401	126.05	8918617
230	206.95	8615021	180.61	8701003	142.99	8700923
240	178.73	8925219	148.63	8612602	137.34	8730007
250	141.10	8615618	161.80	8828913	139.22	8612519
260	146.75	8616619	144.87	8732010	142.99	8708623
270	190.02	8616620	184.38	8701004	154.27	8710509
280	169.33	8620418	167.44	8701006	150.51	8620508
290	220.12	8708412	199.43	8816521	188.14	8925220
300	227.65	8829509	178.73	8816520	169.33	8829510
310	199.43	8728813	188.14	8728811	167.44	8809008
320	220.12	8812609	180.61	8619809	178.73	8619810
330	191.90	8818709	161.80	8618618	161.80	8820809
340	174.97	8500417	173.09	8501817	169.33	8900418
350	174.97	8626511	171.21	8606309	165.56	8620419
360	195.67	8501422	191.90	8821120	188.14	8501420

Notes:

a - Source: (MDEP, 1993).

b - Highlighted concentration in excess of MDEP 1-hour NO₂ policy guideline value of 320 µg/m³.

$\mu\text{g}/\text{m}^3$) to this modeled exceedance. Consequently, the height was raised an additional 10 ft which caused the total 1-hour NO_2 impacts to be in compliance. No other direction-specific exceedances were identified for individual or composite structures at this stack height.

Non-River-Tunnel Alternative. For VB 8, a stack height of at least 330 ft (100.6 m) was determined to be necessary to demonstrate compliance with the applicable 1-hour NO_2 guideline values within the cavity region.

SCREEN model results for the 300 ft composite structure, an initial stack height of 320 ft (97.5 m), and both omni-directional and direction-specific alongwind/crosswind building dimension showed a total 1-hour NO_2 impact slightly greater than the 320 $\mu\text{g}/\text{m}^3$ guideline value. For the direction-specific case (140° downwind sector), emissions from VB 8 contributed significantly to this initially modeled exceedance (39.34 $\mu\text{g}/\text{m}^3$). Consequently, the height was raised an additional 10 ft, at which compliance was demonstrated. No other direction-specific exceedances were identified for individual or composite structures at this stack height.

Additionally, the cavity of Building 4 (Boston Garden Tower A) captured emissions of VB 8. However, it was shown the stack height of 330 ft (100.6 m) was sufficient for compliance demonstration.

Reduced-River-Tunnel Alternative. For VB 8, the initial stack height of 320 ft (97.5 m) was determined to be satisfactory by demonstrating compliance with the applicable 1-hour NO_2 guideline values within the cavity region.

SCREEN model results for both the 155 ft and 300 ft composite structures and the initial stack height of 320 ft were found to be insignificant using omni-directional alongwind/crosswind building dimensions and direction-specific dimensions for the 110° sector.

The cavities produced by the Future Boston Garden Towers A and B were found to capture the plume emitted by VB 8. Impacts within these cavities were slightly above the 32 $\mu\text{g}/\text{m}^3$ significant impact level (ranging from about 34 to 37 $\mu\text{g}/\text{m}^3$). However, background values associated with the potentially affected downwind sectors (310° clockwise through 10°) were low. Thus, the total concentration within these cavities were in compliance with the MDEP policy guideline.

For VB 9, a stack height of at least 105 ft (32.0 m) was determined to be necessary to demonstrate compliance with the applicable 1-hour NO_2 guideline values within the cavity region.

This height was obtained by iteratively estimating impacts within the cavity region caused by the ventilation building itself, since none of the other structures considered for VB 8 produced cavities which intercepted the stack plume from VB 9.

While SCREEN model results based on this stack height and omni-directional alongwind/crosswind building dimensions are significant (about 64 $\mu\text{g}/\text{m}^3$), the plume was shown to escape the cavity region when direction-specific building dimensions are used for the potentially affected downwind sectors (130° and 140°).

The Garage Building. An automobile garage is expected to be built over the railroad tracks, adjacent to the areas zoned for future development (Figs. 7-1 through 7-3). It is important to evaluate air quality at this location. However, due to its proximity to VB 8, the cavity calculations performed for each design alternative also apply to this building. Since compliance within the cavity was demonstrated above, no further analysis is warranted.

7.2.3 DISPERSION CALCULATIONS

For receptors located at distances beyond the cavity region, the ISCST2 model was used to calculate 1- and 8-hour average concentrations for CO, 1-hour and annual average concentrations for NO₂, and 24-hour and annual average concentrations for PM₁₀.

Comprehensive Receptor Network. A polar coordinate receptor grid, was centered on the center of the proposed VB 8 for each design alternative. Polar receptors were located at 100 m intervals, from 100 to 2,000 m at 10° sectors, along 36 directions. The polar receptor network was assumed to be located on flat terrain.

Discrete receptors were placed at sensitive locations such as air intakes or operable windows of nearby buildings, residences and hospitals. In the areas of future development, where air intakes have not been defined, receptors were placed on the building top. For buildings higher than 200 ft, another receptor was added at building mid-height to account for possible air intakes at this level. A list of discrete receptors is given in Table 7-8. The location of nearby buildings where discrete receptors have been placed are shown in Figures 7-1 through 7-4. For the areas further away from the proposed VB 8, the selected discrete receptor at Cambridge, Charlestown and Beacon Hill are illustrated in Figure 7-5.

To ensure that maximum impacts on elevated terrain were assessed, additional discrete receptors were placed at elevated terrain points on Beacon Hill and Bunker Hill. Beacon Hill is located approximately 1.2 km south of the proposed VB 8. Bunker Hill is located in Charlestown, approximately 1.3 km northeast of the proposed VB 8.

Meteorological Data. The most recent five years of readily available hourly surface meteorological data (1985-1989), collected at Boston Logan Airport, a first-order National Weather Service (NWS) station, was used in the modeling analyses. Concurrent daily mixing height values were obtained from upper-air data collected at the Portland, Maine NWS station (B/PB, 1993).

EPA modeling guidance recognizes that 5 years of consecutive data accounts for year to year variability in meteorological parameters. Due to the proximity of these NWS stations to the project site, these locations offer the most regionally representative and readily available database for this study.

Automation Of The OLM. Five years of 1-hour average hourly background data of NO₂ and O₃, for the period 1985 through 1989, have been provided by MDEP. The concurrent 5 years of hourly NO_x concentrations resulting from the ventilation building emissions, at each modeled receptor, were calculated using the ISCST2 model.

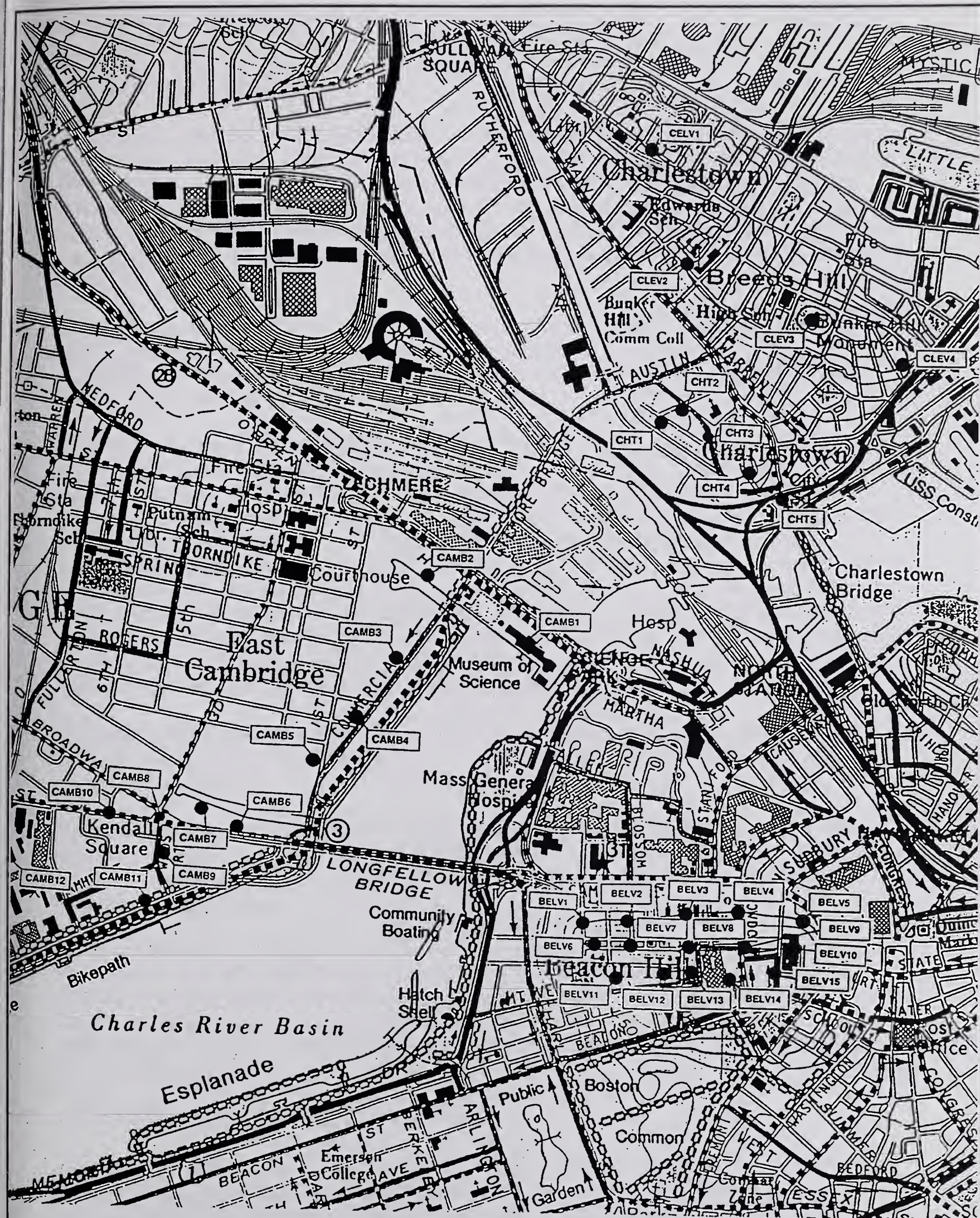
For each model run, the one year 1-hour concentrations for each model receptor were output to an unformatted POST file (an ISCST2 feature). These three sets of concurrent data (i.e. background NO₂, background O₃, and modeled NO_x), were used to calculate the total NO₂ 1-hour concentrations, using the OLM (see Section 7.1.4).

If the modeled NO₂ project impact was greater than 32 µg/m³, at any receptor for any hour, that value was printed along with the concurrent background 1-hour O₃, NO₂, and total NO₂ level (project plus background). If the total NO₂ concentration was greater than 320 µg/m³, an exceedance to the MDEP standard was found. More than one exceedance per year constitutes a violation of MDEP's 1-hour guideline for NO₂.

Table 7-8
DISCRETE RECEPTORS FOR VENTILATION BUILDING EMISSION ANALYSIS

Receptor	Description	Receptor Heights (m)
Cambridge		
CAMB1	Museum of Science	11, 22
CAMB2	Cambridge side Galleria	11
CAMB3	Royal Sonesta Hotel	22, 44
CAMB4	River Court Apartment	25.5, 51
CAMB5	Thinking Machines Corp.	29.3, 58.5
CAMB6	Bay State Health Care	33, 66
CAMB7	Kendall Square	0
CAMB8	One Broadway	29.3, 58.5
CAMB9	60 Wadsworth Apartment	55, 110
CAMB10	Cambridge Marriott Hotel	49.5, 99
CAMB11	100 Memorial Dr. Apartment	24, 48
CAMB12	MIT Green Hall	36.5, 73
Charlestown		
CHT1-CHT4 (Bunker Hill)	Apartment	15, 30
CELV1	Elevated Terrain Area	27.5
CELV2	Apartment	12.5
CELV3	Bunker Hill Monument	21.4
CELV4	Park	12.3
Beacon Hill		
BELV1-5	North Side Hill	12
BELV6-10	North Side Hill	18
BELV11-14	North Side Hill	24
BELV12-13	North Side Hill	27
BELV15	North Side Hill	21
Nearby Buildings		
BLDG2	Registry of Motor Vehicles	51.2
BLDG3	Suffolk County Jail	24.4
BLDG4	Future Boston Garden Tower A	138.4, 69.2
BLDG5	New Boston Gardens Building	49.4
BLDG6	Future Boston Garden Tower C	141.5, 70.8
BLDG7	Future Boston Garden Tower B	114.6, 57.3
BLDG8	Thomas O'Neill Federal Bldg.	38.1
BLDG9	Charles River Park Garage	16.8
BLDG10	Amy Lowell House	38.1
BLDG11	Longfellow Place Apartments	53.4
BLDG12	Longfellow Place Apartments	53.4
BLDG13	5, 6, and 7 Whittier Place	53.4
BLDG14	8 Whittier Place	71.3, 35.7
BLDG15	10 Emerson Place Apartments	76.2, 38.1
BLDG16	One Emerson Place Apartments	57

Source: Bechtel/Parsons Brinckerhoff



FIGURE

7.5

Discrete Receptor Network At Cambridge, Charlestown, And Beacon Hill

Charles River Crossing DSEIS/R

MASSACHUSETTS HIGHWAY DEPARTMENT
CENTRAL ARTERY/TUNNEL PROJECT



7.3 MODEL RESULTS

As discussed in Section 7.2.2, a cavity analysis using the SCREEN model was performed to evaluate pollutant concentrations resulting from the proposed ventilation building emissions within a building-induced cavity. Through an iteration process, a stack height which is in compliance with all the applicable AAQS and air quality guidelines was determined for each of the new design alternatives. For estimating air quality levels at distances beyond the cavity, pollutant concentrations based on the stack height determined in the cavity analysis were calculated using the ISCST2 model as discussed in Section 7.2.3.

Stack height as determined in the cavity analysis are 330 feet for both the 8.1D Mod. 5 alternative and the Non-River-Tunnel alternative. Stack heights required for the Reduced River-Tunnel alternative are 320 feet for VB 8 and 105 feet for VB 9. All the model results reported below are based on these stack heights.

Based on five years of meteorological data (1985-1989), the maximum hourly CO concentrations for each modeled year at distances beyond the cavity region are presented in Table 7-9, for the three design alternatives. The overall maximum are presented in Table 7-10. Maximum hourly CO concentrations within the cavity region are also reported in the same table. Similar information for NO₂ is summarized in Table 7-11. As indicated in these tables, the maximum calculated concentrations for all alternatives occurred in the immediate vicinity of the ventilation site, within the cavity produced by the ventilation building, or the adjacent future development complex. Operation of VB 9 for the Reduced River-Tunnel alternative resulted in maximum ground concentrations of 64.4 µg/m³ for NO₂ and 0.44 ppm for CO. These high concentrations are due to limited dilution produced by a relatively small cavity created by VB 9 as compared to better dilution from a much larger cavity created by the entire future development complex situated on top of VB 8.

The highest second-highest 8-hour CO and 24-hour PM₁₀ concentrations, and the highest annual NO₂ and PM₁₀ concentrations at distances beyond the cavity are presented in Tables 7-12 through 7-14 for all analyzed alternatives.

For the concentration calculations for distances beyond the cavity, all the hourly maximum values occurred at elevated receptors situated either on the nearby tall buildings, or on the surrounding hills (Tables 7-15 through 7-17). Elevated receptors are generally subjected to higher impacts due to direct plume impingement.

As shown in Tables 7-9 through 7-17, higher pollutant impacts were predicted for the year 2010. The highest 1-hour NO₂ and CO concentrations are associated with the Reduced River-Tunnel Alternative and the highest 8-hour CO concentration (0.07 ppm) is associated with Alternative 8.1D Mod 5. Modeling results also indicate that 8.1D Mod 5 produces the highest 24-hour PM₁₀ concentration (1.4 µg/m³). The Reduced River-Tunnel Alternative results in higher annual impacts for both NO₂ and PM₁₀.

7.4 COMPARISONS OF ALTERNATIVES

As in the 1991 FSEIS/R, Scheme Z employs bridges for crossing the Charles River. This scheme does not require any ventilation buildings because it has no tunnels north of Causeway Street. Therefore, the air quality impacts caused by the ventilation building emissions for each of the alternatives alone can be viewed as incremental impacts relative to the Scheme Z design.

Table 7-9

**CHARLES RIVER CROSSING ALTERNATIVES
MAXIMUM 1-HOUR CO IMPACTS (ppm) BEYOND THE CAVITY**

YEAR 2001

	8.1D Mod. 5	NRT	RRT
1985	0.21	0.05	0.15
1986	0.27	0.07	0.15
1989	0.20	0.07	0.14
1988	0.20	0.06	0.15
1989	0.08	0.06	0.14
Max.	0.27	0.07	0.15
Significant Impact Level	1.75	1.75	1.75

YEAR 2010

	8.1D Mod. 5	NRT	RRT
1988	0.27	0.06	0.20
1989	0.05	0.08	0.20
1988	0.26	0.26	0.19
1988	0.26	0.07	0.13
1989	0.21	0.07	0.18
Max.	0.36	0.08	0.20
Significant Impact Level	1.75	1.75	1.75

Notes:

Three design alternatives:

Alternative 1 - 8.1d Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Cavity - the area of disturbed air flow, normally extending 3 building heights downwind of a structure.

Source: Bechtel/Parsons Brinckerhoff

Table 7-10

**CHARLES RIVER CROSSING ALTERNATIVES
MAXIMUM 1-HOUR CO IMPACTS (ppm) FOR ALL DOWNWIND DISTANCES**

YEAR 2001

	8.1D Mod.5	NRT	RRT VB 8	RRT VB 9
Within Cavity	0.21	0.23	0.19	0.32
Beyond Cavity	0.27	0.07	0.15	
Significant Impact Level	1.75	1.75	1.75	

YEAR 2010

	8.1D Mod.5	NRT	RRT VB 8	RRT VB 9
Within Cavity	0.28	0.27	0.24	0.44
Beyond Cavity	0.36	0.08	0.20	
Significant Impact Level	1.75	1.75	1.75	

Notes:**Three design alternatives:**

Alternative 1 - 8.1d Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Cavity - The area of disturbed air flow, normally extending 3 building heights downwind of a structure.

Source: Bechtel/Parsons Brinckerhoff

Table 7-11

**CHARLES RIVER CROSSING ALTERNATIVES
MAXIMUM 1-HOUR NO₂ IMPACTS ($\mu\text{g}/\text{m}^3$)**

YEAR 2001

	8.1D Mod.5	NRT	RRT VB 8	RRT VB 9
Within Cavity	31.6	36.2	31	59.2
Beyond Cavity	41.6	11.1	26.7	
MDEP Significant Impact Level	32	32	32	

YEAR 2010

	8.1D Mod.5	NRT	RRT VB 8	RRT VB 9
Within Cavity	35.2	39.1	37.5	64.4
Beyond Cavity	46.4	12	29	
MDEP Significant Impact Level	32	32	32	

Notes:

A maximum conversion rate (100%) of NO_x to NO₂ was assumed.

Three design alternatives:

Alternative 1 - 8.1d Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Cavity - The area of disturbed air flow, normally extending 3 building heights downwind of a structure.

Source: Bechtel/Parsons Brinckerhoff

Table 7-12

**CHARLES RIVER CROSSING ALTERNATIVES
MAXIMUM 8-HOUR CO IMPACTS (ppm)**

YEAR 2001

	8.1D Mod. 5	NRT	RRT
1985	0.06	0.02	0.03
1985	0.06	0.01	0.03
1987	0.05	0.01	0.03
1988	0.04	0.01	0.03
1988	0.04	0.01	0.02
Max.	0.06	0.02	0.03
Significant Impact Level	0.44	0.44	0.44

YEAR 2010

	8.1D Mod. 5	NRT	RRT
1985	0.07	0.02	0.04
1986	0.05	0.02	0.03
1987	0.05	0.01	0.04
1987	0.05	0.01	0.04
1987	0.05	0.01	0.03
Max.	0.07	0.02	0.04
Significant Impact Level	0.44	0.44	0.44

Notes:

The results are produced by ISCST2.

Three design alternatives:

Alternative 1 - 8.1D Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Source: Bechtel/Parsons Brinckerhoff

Table 7-13

**CHARLES RIVER CROSSING ALTERNATIVES
MAXIMUM PM₁₀ IMPACTS**

**YEAR 2010
24-HOUR AVERAGES ($\mu\text{g}/\text{m}^3$)**

	8.1D Mod. 5	NRT	RRT
1985	1.1	0.3	1.0
1986	1.4	0.3	0.6
1987	0.8	0.2	0.7
1985	0.7	0.2	0.6
1985	0.6	0.2	0.7
Max.	0.3	0.5	1.0
Significant Impact Level	5.0	5.0	5.0

ANNUAL AVERAGES ($\mu\text{g}/\text{m}^3$)

	8.1D Mod. 5	NRT	RRT
1985	0.09	0.03	0.10
1985	0.08	0.02	0.08
1987	0.08	0.02	0.09
1989	0.08	0.02	0.09
1989	0.08	0.03	0.09
Max.	0.09	0.03	0.10
Significant Impact Level	1.00	1.00	1.00

Notes:

The results are produced by ISCST2.

Three design alternatives:

Alternative 1 - 8.1D Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Source: Bechtel/Parsons Brinckerhoff

Table 7-14

**CHARLES RIVER CROSSING ALTERNATIVES
MAXIMUM ANNUAL NO₂ IMPACTS ($\mu\text{g}/\text{m}^3$)**

YEAR 2001

	8.1D Mod. 5	NRT	RRT
1986	0.39	0.12	0.41
1986	0.39	0.09	0.35
1987	0.39	0.10	0.35
1988	0.35	0.10	0.35
1989	0.36	0.09	0.39
Max.	0.39	0.12	0.41
Significant Impact Level	1.00	1.00	1.00

YEAR 2010

	8.1D Mod. 5	NRT	RRT
1985	0.41	0.10	0.44
1986	0.36	0.10	0.37
1987	0.35	0.10	0.35
1988	0.36	0.11	0.41
1989	0.38	0.10	0.38
Max.	0.41	0.10	0.44
Significant Impact Level	1.00	1.00	1.00

Notes:

The results are produced by ISCST2.

Three design alternatives:

Alternative 1 - 8.1D Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Source: Bechtel/Parsons Brinckerhoff

Table 7-15

**LOCATION OF MAXIMUM 1-HOUR NO₂ IMPACTS
8.1D Mod.5 ALTERNATIVE**

YEAR 2001

Year	Location	Impact ($\mu\text{g}/\text{m}^3$)	Elevation (m)
1985	8 Whittier Place	31.4	71
1986	Beacon Hill	41.6	27
1987	8 Whittier Place	30.2	71
1988	8 Whittier Place	30.2	71
1989	10 Emerson Place Apts.	23.7	76
MDEP Significant Impact Level		32	all

YEAR 2010

Year	Location	Impact ($\mu\text{g}/\text{m}^3$)	Elevation (m)
1985	8 Whittier Place	35.0	71
1986	Beacon Hill	46.4	27
1987	8 Whittier Place	33.7	71
1988	8 Whittier Place	33.7	71
1989	10 Emerson Place Apt.	26.4	76
MDEP Significant Impact Level		32	all

Note:

A maximum conversion rate (100%) of NO_x to NO₂ was assumed.

Source: Bechtel/Parsons Brinckerhoff

Table 7-16

**LOCATION OF MAXIMUM 1-HOUR NO₂ IMPACTS
NON-RIVER-TUNNEL ALTERNATIVE**

YEAR 2001

Year	Location	Impact ($\mu\text{g}/\text{m}^3$)	Elevation (m)
1985	8 Whittier Place	8.2	71
1986	8 Whittier Place	11.1	71
1987	8 Whittier Place	11.1	71
1988	8 Whittier Place	9.1	71
1989	8 Whittier Place	9.3	71
MDEP Significant Impact Level		32	na

YEAR 2010

Year	Location	Impact ($\mu\text{g}/\text{m}^3$)	Elevation (m)
1985	8 Whittier Place	8.9	71
1986	8 Whittier Place	12.0	71
1987	8 Whittier Place	12.0	71
1988	8 Whittier Place	9.9	71
1989	8 Whittier Place	10.0	71
MDEP Significant Impact Level		32	na

Note:

A maximum conversion rate (100%) of NO_x to NO₂ was assumed.

Source: Bechtel/Parsons Brinckerhoff

Table 7-17

**LOCATION OF MAXIMUM 1-HOUR NO₂ IMPACTS
REDUCED-RIVER-TUNNEL ALTERNATIVE**

YEAR 2001

Year	Location	Impact ($\mu\text{g}/\text{m}^3$)	Elevation (m)
1985	Cambridge*	26.7	35
1986	Registry of Motor Vehicles	26.7	51
1987	Cambridge*	25.2	75
1986	Cambridge*	17.8	35
1989	Cambridge*	23.7	35
MDEP Significant Impact Level		32	na

YEAR 2010

Year	Location	Impact ($\mu\text{g}/\text{m}^3$)	Elevation (m)
1985	Cambridge*	29	35
1986	Registry of Motor Vehicles	29	51
1987	Cambridge*	27.4	75
1988	Cambridge*	19.4	35
1989	Cambridge*	25.7	35
MDEP Significant Impact Level		32	na

Notes:

A maximum conversion rate (100%) of NO_x to NO₂ was assumed.

* - Future development in Cambridge

Source: Bechtel/Parsons brinckerhoff

Incremental impacts for the three new design alternatives are reported in Tables 7-9 through 7-17. Significant impact levels, below which insignificant effects to public health are expected, are also given in these tables for comparison.

Model results show that all of the proposed design alternatives have insignificant incremental impacts for all pollutants under consideration, except for NO₂. For the Reduced River-Tunnel alternative, the 1-hour NO₂ impact resulted from VB 9 emissions is slightly above the MDEP significant impact level (32 µg/m³). However, this concentration is only 20 % of the MDEP ambient hourly guideline value (320 µg/m³).

Based on the results presented in Tables 7-9 through 7-17, one can also conclude that the air quality impact differences are small among the three new design alternatives. Selection of the 8.1D Mod.5 alternative will result in higher 8-hour CO and 24-hour PM₁₀ impacts. The Reduced River-Tunnel alternative yields the highest 1-hour impacts for both NO₂ and CO and annual impacts for both NO₂ and PM₁₀.

In summary, based on the proposed vent heights as determined in the cavity analysis, the operation of the ventilation buildings for all three design alternatives will have minimal effects on the surrounding environment. It is worth reiterating that these stack heights were determined by assuming a full-build condition within the nearby future development complex.

The demonstration of compliance with all the applicable air quality regulations and standards is presented in Section 8.

8 COMBINED AIR QUALITY IMPACTS

8.1 ALL VENTILATION BUILDINGS

Sections 7.3 and 7.4 conclude that pollutant (CO, NO₂, PM₁₀) impacts due to the operation of the proposed VB 8 (and VB 9 for the Reduced River-Tunnel alternative) alone have minimal effect on the surrounding environment. In addition to ventilation building(s) for the Charles River Crossing, the project has six other planned ventilation buildings (VB 1, 3, 4, 5, 6, and 7). These other buildings are located at least 2000 ft from both the proposed VB 8 and VB 9. However, under certain meteorological conditions, it is possible for the exhaust plumes from various ventilation buildings to merge, causing a combined air quality impact greater than that from VB 8 alone or VBs 8 and 9 combined. Therefore, the combined impact from all ventilation building emissions was also modeled for the compliance demonstration.

Total concentrations used in the compliance demonstration also include the background levels in the project area. If these total concentrations are less than the corresponding applicable standards and the MDEP's 1-hour policy guideline value for NO₂, then a satisfactory demonstration of compliance is considered to have been made.

Ventilation building emission rates and building design parameters input to the ISCST2 model calculations are given in Tables 7-5 and 7-6.

The modeling results indicate that the maximum impact locations for all of the ventilation building emission sources combined (VB 1 - 9) are elevated receptors located on tall buildings near the Parcel

7 site (VB 4) Haymarket Area for all pollutants considered. The relative contributions from VB 8 and 9 at these maximum impact locations are insignificant.

CO Impacts. Combined CO impacts for 1- and 8-hour averaging times were evaluated for the years 2001 (Table 8-1) and 2010 (Table 8-2). The maximum combined CO concentrations from all ventilation buildings when added to their appropriate background concentrations were well below the corresponding National and Massachusetts AAQS. Higher impacts occurred for the year 2010 due to higher vehicle emission rates forecast for that year. The maximum total CO concentrations are 2% and 33% of their corresponding 1-hour and 8-hour AAQS, respectively. Note too, that the differences between the three design alternatives are minimal, and that impacts for the Non-River-Tunnel alternative are slightly less than the other two alternatives.

NO₂ Impacts. Combined 1-hour NO₂ impacts from all ventilation buildings, as shown in Table 8-3, were also evaluated for the years 2001 and 2010. The maximum combined NO_x impacts from all ventilation buildings were first estimated by the ISCST2 model and then converted to NO₂ levels using the OLM. The highest maximum level is about 81% of the MDEP guideline value (320 µg/m³) for the three design alternatives, for both years analyzed.

Combined annual NO₂ impacts for all ventilation buildings for years 2001 and 2010 are reported in Table 8-4. The results indicate that the maximum total NO₂ annual concentrations are 62% and 63% of the annual AAQS for years 2001 and 2010, respectively. No significant differences were found among the three design alternatives.

PM₁₀ Impacts. Combined PM₁₀ impacts for all ventilation buildings were evaluated for the higher emission year 2010 (Table 8-5). The combined maximum 24-hour and annual PM₁₀ concentrations, when added to their appropriate background concentrations were all below the corresponding National and Massachusetts AAQS. The maximum total 24-hour and annual PM₁₀ concentrations are 70% and 78% of their corresponding AAQS, respectively. As with CO and NO₂ no significant differences were found among the three design alternatives.

8.2 MOBILE SOURCES AND VENTILATION BUILDINGS

As Section 3.3 describes, CO levels resulting from project related vehicle emissions were estimated by the CAL3QHC mobile source dispersion model at 23 critical intersections that could be affected by the project design alternatives. Maximum 1- and 8-hour CO concentrations modeled by CAL3QHC for Scheme Z and the three design alternatives are presented in Tables 6-2 and 6-3, respectively, for the Project Completion Year (2001). Similar information is presented in Tables 6-4 and 6-5 for the Project Design Year (2010). Appropriate background CO levels for the study area, as described in Section 6.1.6, are also included in the reported results.

The mobile source impact analysis, Section 6.1.5, was based on conditions assumed by the model to represent the worst case meteorology (i.e., stability D and 1 m/s wind speed). The ISCST2 model was run using these meteorological conditions to calculate concentrations from all the ventilation buildings at the same critical intersections. The maximum 1- and 8-hour CO concentrations predicted by ISCST2 for the project years 2001 and 2010 are presented in Tables 8-6, 8-7 and 8-8, for the three alternatives. Since Scheme Z does not employ any ventilation building, no ISCST2 modeling was performed for this scenario. The results indicate that the ventilation building CO impacts are one to two orders of magnitude less than the levels resulting from traffic at intersections for all averaging periods.

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Table 8-1

**MAXIMUM COMBINED CO LEVELS
YEAR 2001**

1-HOUR AVERAGE (ppm)

	8.1D Mod. 5	NRT	RRT
1985	1.43	1.36	1.43
1986	1.40	1.26	1.40
1987	1.52	1.43	1.52
1986	0.78	0.78	0.78
1985	1.93	1.81	1.93
Background	1.40	4.00	4.00
Maximum Total	5.93	5.81	5.93
AAQS	35.00	35.00	35.00

8-HOUR AVERAGE (ppm)

	8.1D Mod. 5	NRT	RRT
1985	0.28	0.26	0.28
1986	0.28	0.20	0.24
1987	0.25	0.24	0.25
1987	0.18	0.78	0.18
1987	0.30	0.26	0.30
Background	2.40	2.66	2.40
Maximum Total	2.70	2.66	2.70
AAQS	9.00	9.00	9.00

Notes:

Three design alternatives:

Alternative 1 - 8.1D Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Combined level includes highest second-highest concentrations due to emissions from VB 1 - 9, as well as all background sources from monitoring.

Source: Bechtel/Parsons Brinckerhoff

Table 8-2

**MAXIMUM COMBINED CO LEVELS
YEAR 2010**

1-HOUR AVERAGE (ppm)

	8.1D Mod. 5	NRT	RRT
1985	2.10	2.60	2.10
1986	2.05	1.85	0.35
1987	2.24	2.83	0.23
1985	1.14	1.85	1.14
1986	2.83	2.66	2.83
Background	4.40	4.40	4.40
Maximum Total	2.83	7.06	7.23
AAQS	35.00	35.00	35.00

8-HOUR AVERAGE (ppm)

	8.1D Mod. 5	NRT	RRT
1985	0.35	0.30	0.35
1986	0.32	0.25	0.30
1987	0.32	0.31	0.30
1985	0.23	0.20	0.23
1985	0.37	0.30	0.37
Background	2.60	2.66	2.60
Maximum Total	2.97	2.92	2.97
AAQS	9.00	9.00	9.00

Notes:

Three design alternatives:

Alternative 1 - 8.1D Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Combined level includes highest second-highest concentrations due to emissions from VB 1 - 9, as well as all background sources from monitoring.

Source: Bechtel/Parsons Brinckerhoff

Table 8-3

MAXIMUM COMBINED 1-HOUR NO₂ LEVELS (µg/m³)

YEAR 2001

Year	1985			1986			1987			1988			1989		
	ISC	B.G.	OLM	ISC	B.G.	OLM	ISC	B.G.	OLM	ISC	B.G.	OLM	ISC	B.G.	OLM
8.1D	76	119	190	103	190	260	65	122	175	43	124	159	109	137	198
NRT	76	119	179	100	190	260	61	122	172	48	124	158	105	137	198
RRT	76	119	183	103	190	260	65	122	175	48	124	159	109	137	199

YEAR 2010

Year	1985			1986			1987			1988			1989		
	ISC	B.G.	OLM	ISC	B.G.	OLM	ISC	B.G.	OLM	ISC	B.G.	OLM	ISC	B.G.	OLM
8.1D	86	119	190	119	190	261	76	122	184	50	124	165	126	137	199
NRT	86	119	188	116	190	261	71	122	190	48	124	163	121	137	198
RRT	88	119	190	119	190	261	76	122	184	50	124	165	126	137	199

Notes:

ISC - ISCST2 output (All the ISC results are greater than the MDEP NO₂ 1-hour significant impact level, 32 µg/m³).

B.G. - Concurrent background value

OLM - Calculated using the OLM (All the OLM results are less than the MDEP NO₂ 1-hour policy guideline, 320 µg/m³).

Three design alternatives:

Alternative 1 - 8.1D Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Combined level includes modeled highest second-highest concentrations due to emissions from VB 1 - 9, plus highest background concentrations from monitoring.

Source: Bechtel/Parsons Brinckerhoff

Table 8-4

**MAXIMUM COMBINED ANNUAL NO₂ LEVELS ($\mu\text{g}/\text{m}^3$)
YEAR 2001**

	8.1D Mod. 5	NRT	RRT
1985	1.56	1.40	1.50
1986	1.62	1.44	1.57
1988	2.29	2.08	2.25
1988	1.38	1.22	1.34
1988	2.11	1.89	2.06
Background	60.0	60.0	60.0
Maximum Total	62.3	62.1	62.3
AAQS	100	100	100

YEAR 2010

	8.1D Mod. 5	NRT	RRT
1985	1.71	1.54	1.66
1986	1.78	1.54	1.73
1987	2.52	2.29	2.47
1988	1.51	1.35	1.47
1987	2.31	2.08	2.27
Background	60.0	60.0	60.0
Maximum Total	62.5	62.3	62.5
AAQS	100	100	100

Notes:

Three design alternatives:

Alternative 1 - 8.1D Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8 and 9

Combined level includes modeled highest concentrations due to emissions from VB 1 - 9, plus highest background concentrations from monitoring.

Source: Bechtel/Parsons Brinckerhoff

Table 8-5

**MAXIMUM COMBINED PM₁₀ LEVELS ($\mu\text{g}/\text{m}^3$)
YEAR 2010**

24-HOUR AVERAGE

	8.1D Mod. 5	NRT	RRT
1986	9.3	7.4	9.3
1986	8.0	6.9	8.0
1988	8.0	7.4	8.0
1988	8.0	6.9	4.8
1989	7.9	6.9	7.9
Background	96.0	96.0	38.0
Maximum Total	105.3	103.8	105.3
AAQS	150	150	150

ANNUAL AVERAGE

	8.1D Mod. 5	NRT	RRT
1985	0.86	0.53	0.50
1986	0.60	0.55	0.50
1989	0.86	0.79	0.78
1988	0.51	0.46	0.50
1989	0.86	0.72	0.78
Background	38.0	38.0	38.0
Maximum Total	38.9	38.8	38.9
AAQS	50	50	50

Notes:

Three design alternatives:

Alternative 1 - 8.1D Mod5, VB 8;

Alternative 2 - Non-River-Tunnel (NRT), VB 8 and 9;

Alternative 3 - Reduced-River-Tunnel (RRT), VB 8

Combined level includes modeled highest second-highest 24-hour average concentrations due to emissions from VB 1 - 9, plus highest background concentrations from monitoring.

Source: Bechtel/Parsons Brinckerhoff

Table 8-6

**MAXIMUM 1- AND 8-HOUR CO IMPACTS AT WORST INTERSECTIONS
FROM VENTILATION BUILDING - 8.1D Mod. 5 ALTERNATIVE
(ppm)**

No.	Location	Year 2001		Year 2010	
		1-Hour	8-Hour	1-Hour	8-Hour
1.	Gilmore Bridge & O'Brien Highway	0.09	0.06	0.11	0.07
2.	City Square	0.07	0.05	0.10	0.05
3.	Leverett Circle	0.04	0.03	0.09	0.03
4.	Causeway/Merrimac/Lomasney	0.10	0.05	0.13	0.05
5.	Causeway & Haverhill Rd.	0.03	0.03	0.05	0.03
6.	Causeway & Beverly Rd.	0.09	0.05	0.09	0.06
7.	North Washington & Commercial (Keeny Sq.)	0.07	0.05	0.09	0.06
8.	New Sudbury & Congress Streets	0.09	0.03	0.12	0.07
9.	New Chardon/Haverhill/North Washington	0.10	0.05	0.13	0.05
10.	New Chardon/Stillman/North Washington	0.10	0.08	0.10	0.08
14.	Congress & State Streets	0.07	0.05	0.09	0.06
15.	State St. & Surface Rd.	0.06	0.05	0.10	0.05
34.	Cambridge & Staniford Streets	0.07	0.06	0.10	0.06
40.	New Rutherford/C-L @ Bunker Hill College	0.10	0.06	0.11	0.07
41.	New Rutherford & Gilmore Bridge	0.09	0.07	0.12	0.08
42.	New Rutherford/BS & G	0.06	0.06	0.09	0.05
43.	Lechmere Square	0.03	0.09	0.19	0.11
44.	Nashua Street and Martha Rd.	0.13	0.07	0.05	0.03
45.	Cambridge & New Chardon Streets	0.09	0.07	0.12	0.08
46.	Cambridge & New Sudbury Streets	0.09	0.06	0.11	0.07
47.	Charles Circle	0.09	0.06	0.10	0.06
48.	Broadway & Third Street	0.05	0.04	0.07	0.05
49.	Sullivan Square	0.07	0.05	0.09	0.06

Notes: Analysis sites numbered 1 to 34 coincide with numbering utilized in the 1990 FSEIS/R.
Locations 40 - 49 are new sites.

CO AAQS: 1-hour (35 ppm), 8-hour (9 ppm)

Source: Bechtel/Parsons Brinckerhoff

Table 8-7

**MAXIMUM 1- AND 8-HOUR CO IMPACTS AT WORST INTERSECTIONS
FROM VENTILATION BUILDING - NRT ALTERNATIVE
(ppm)**

No.	Location	Year 2001		Year 2010	
		1-Hour	8-Hour	1-Hour	8-Hour
1.	Gilmore Bridge & O'Brien Highway	0.05	0.03	0.07	0.04
2.	City Square	0.07	0.04	0.10	0.05
3.	Leverett Circle	0.04	0.02	0.06	0.03
4.	Causeway/Merrimac/Lomasney	0.03	0.03	0.05	0.03
5.	Causeway & Haverhill Rd.	0.07	0.03	0.05	0.03
6.	Causeway & Beverly Rd.	0.06	0.03	0.05	0.03
7.	North Washington & Commercial (Keeny Sq.)	0.04	0.03	0.06	0.04
8.	New Sudbury & Congress Streets	0.03	0.03	0.05	0.03
9.	New Chardon/Haverhill/North Washington	0.04	0.03	0.05	0.03
10.	New Chardon/Stillman/North Washington	0.04	0.03	0.05	0.03
14.	Congress & State Streets	0.02	0.02	0.03	0.02
15.	State St. & Surface Rd.	0.02	0.01	0.03	0.02
34.	Cambridge & Staniford Streets	0.03	0.02	0.04	0.03
40.	New Rutherford/C-L @ Bunker Hill College	0.07	0.04	0.10	0.06
41.	New Rutherford & Gilmore Bridge	0.06	0.04	0.09	0.05
42.	New Rutherford/BS & G	0.06	0.04	0.09	0.05
43.	Lechmere Square	0.07	0.04	0.10	0.06
44.	Nashua Street and Martha Rd.	0.03	0.02	0.05	0.03
45.	Cambridge & New Chardon Streets	0.03	0.02	0.06	0.03
46.	Cambridge & New Sudbury Streets	0.03	0.02	0.04	0.02
47.	Charles Circle	0.05	0.03	0.08	0.04
48.	Broadway & Third Street	0.05	0.03	0.07	0.04
49.	Sullivan Square	0.06	0.03	0.08	0.04

Notes: Analysis sites numbered 1 to 34 coincide with numbering utilized in the 1990 FSEIS/R.
Locations 40 - 49 are new sites.

CO AAQS: 1-hour (35 ppm), 8-hour (9 ppm)

Source: Bechtel/Parsons Brinckerhoff

Table 8-8

**MAXIMUM 1- AND 8-HOUR CO IMPACTS AT WORST INTERSECTIONS
FROM VENTILATION BUILDINGS - RRT ALTERNATIVE
(ppm)**

No.	Location	Year 2001		Year 2010	
		1-Hour	8-Hour	1-Hour	8-Hour
1.	Gilmore Bridge & O'Brien Highway	0.05	0.03	0.07	0.04
2.	City Square	0.07	0.04	0.10	0.05
3.	Leverett Circle	0.04	0.03	0.06	0.03
4.	Causeway/Merrimac/Lomasney	0.03	0.02	0.05	0.03
5.	Causeway & Haverhill Rd.	0.03	0.03	0.05	0.03
6.	Causeway & Beverly Rd.	0.04	0.03	0.05	0.04
7.	North Washington & Commercial (Keeny Sq.)	0.04	0.03	0.06	0.04
8.	New Sudbury & Congress Streets	0.04	0.03	0.06	0.04
9.	New Chardon/Haverhill/North Washington	0.04	0.03	0.04	0.04
10.	New Chardon/Stillman/North Washington	0.04	0.03	0.06	0.04
14.	Congress & State Streets	0.03	0.02	0.04	0.03
15.	State St. & Surface Rd.	0.03	0.02	0.06	0.03
34.	Cambridge & Staniford Streets	0.03	0.02	0.04	0.03
40.	New Rutherford/C-L @ Bunker Hill College	0.07	0.05	0.11	0.06
41.	New Rutherford & Gilmore Bridge	0.07	0.05	0.10	0.06
42.	New Rutherford/BS & G	0.06	0.04	0.06	0.05
43.	Lechmere Square	0.03	0.05	0.10	0.06
44.	Nashua Street and Martha Rd.	0.03	0.02	0.05	0.03
45.	Cambridge & New Chardon Streets	0.04	0.03	0.05	0.03
46.	Cambridge & New Sudbury Streets	0.04	0.03	0.05	0.04
47.	Charles Circle	0.05	0.03	0.07	0.04
48.	Broadway & Third Street	0.05	0.03	0.07	0.04
49.	Sullivan Square	0.06	0.04	0.08	0.04

Notes: Analysis sites numbered 1 to 34 coincide with numbering utilized in the 1990 FSEIS/R.
Locations 40 - 49 are new sites.

CO AAQS: 1-hour (35 ppm), 8-hour (9 ppm)

Source: Bechtel/Parsons Brinckerhoff

To demonstrate compliance, ISCST2 results were added to those predicted by the CAL3QHC model to estimate the maximum combined 1- and 8-hour CO concentrations. These values are presented in Tables 8-9 through 8-12 for the three new design alternatives. The results indicate that the 1-hour maximum combined CO concentrations for both of the analyzed years, occurred at Intersection 7 - North Washington & Commercial Streets, for Scheme Z. These values are all less than 40% of the 1-hour AAQS (35 ppm). The maximum 8-hour combined CO concentrations also occurred at the same intersection for all alternatives considered and are below the 8-hour AAQS (9 ppm). The maximum 8-hour CO concentrations estimated for Scheme Z for both project years are slightly higher than those for the three alternatives.

9 REFERENCES

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I, May.

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MDEP 1993; Letter of Massachusetts Vehicle Registration Data from MDEP, Massachusetts Department of Environmental Protection, March 1993.

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Table 8-9

**ESTIMATED 1-HOUR WORST CASE CO LEVELS INCLUDING CONTRIBUTIONS FROM VENTILATION BUILDINGS
YEAR 2001
(ppm)**

No.	Location	Scheme Z	8.1D Mod5	NRT	RRT
1.	Gilmore Bridge & O'Brien Highway	11.1	<u>11.3</u>	11.1	11.1
2.	City Square	<u>12.2</u>	<u>8.3</u>	<u>9.3</u>	<u>8.3</u>
3.	Leverett Circle	9.2	<u>9.3</u>	9.2	8.7
4.	Causeway/Merrimac/Lomasney	<u>12.8</u>	11.4	12.4	10.8
5.	Causeway & Haverhill Rd.	<u>9.0</u>	<u>8.0</u>	8.0	8.8
6.	Causeway & Beverly Rd.	<u>9.0</u>	8.9	8.7	8.7
7.	North Washington & Commercial (Keeny Sq.)	<u>13.1</u>	12.4	12.7	12.7
8.	New Sudbury & Congress Streets	9.5	8.9	<u>9.8</u>	8.6
9.	New Chardon/Haverhill/North Washington	10.2	9.8	<u>10.5</u>	<u>8.3</u>
10.	New Chardon/Stillman/North Washington	<u>8.0</u>	<u>10.3</u>	10.0	10.3
14.	Congress & State Streets	6.5	<u>6.8</u>	6.5	<u>8.6</u>
15.	State St. & Surface Rd.	<u>9.5</u>	9.3	9.2	9.2
34.	Cambridge & Staniford Streets	<u>12.0</u>	11.6	11.7	<u>11.0</u>
40.	New Rutherford/C-L @ Bunker Hill College	9.2	<u>9.9</u>	9.8	9.6
41.	New Rutherford & Gilmore Bridge	8.8	<u>6.5</u>	8.8	8.6
42.	New Rutherford/BS & G	<u>9.5</u>	<u>8.3</u>	8.8	8.3
43.	Lechmere Square	8.0	7.9	<u>8.1</u>	7.9
44.	Nashua Street and Martha Rd.	<u>10.8</u>	10.3	10.3	10.2
45.	Cambridge & New Chardon Streets	<u>11.7</u>	<u>10.0</u>	10.5	10.3
46.	Cambridge & New Sudbury Streets	<u>11.8</u>	11.1	10.5	11.0
47.	Charles Circle	9.2	8.9	<u>8.1</u>	<u>7.9</u>
48.	Broadway & Third Street	5.8	5.9	5.9	5.9
49.	Sullivan Square	<u>8.5</u>	8.4	8.3	8.3

- Notes:
1. Analysis sites numbered 1 to 34 coincide with numbering utilized in the 1990 FSEIS/R, locations 40 - 49 are new sites.
 2. CO 1-hour AAQS is 35 ppm.
 3. Values include 1-hour CO background level of 4.0 ppm.
 4. Underline indicates greatest impacts.

Source: Bechtel/Parsons Brinckerhoff

Table 8-10

**ESTIMATED 8-HOUR WORST CASE CO LEVELS INCLUDING CONTRIBUTIONS FROM VENTILATION BUILDINGS
YEAR 2001
(ppm)**

No.	Location	Scheme Z	8.1D Mod5	NRT	RRT
1.	Gilmore Bridge & O'Brien Highway	6.6	<u>5.6</u>	5.8	6.6
2.	City Square	<u>7.3</u>	5.1	4.9	4.6
3.	Leverett Circle	5.5	<u>5.6</u>	5.5	5.3
4.	Causeway/Merrimac/Lomasney	<u>7.7</u>	6.3	7.0	4.6
5.	Causeway & Haverhill Rd.	<u>5.4</u>	5.3	4.8	5.3
6.	Causeway & Beverly Rd.	<u>5.4</u>	5.5	5.2	5.2
7.	North Washington & Commercial (Keeny Sq.)	<u>7.8</u>	7.5	7.6	7.6
8.	New Sudbury & Congress Streets	5.7	5.4	<u>5.9</u>	5.3
9.	New Chardon/Haverhill/North Washington	6.1	5.9	<u>5.9</u>	5.9
10.	New Chardon/Stillman/North Washington	5.8	<u>6.2</u>	6.1	6.2
14.	Congress & State Streets	3.9	<u>4.1</u>	4.9	3.9
15.	State St. & Surface Rd.	<u>5.7</u>	5.4	5.5	5.5
34.	Cambridge & Staniford Streets	<u>7.2</u>	7.0	4.9	7.0
40.	New Rutherford/C-L @ Bunker Hill College	5.5	<u>6.0</u>	5.8	5.8
41.	New Rutherford & Gilmore Bridge	<u>5.3</u>	5.3	5.2	5.2
42.	New Rutherford/BS & G	<u>5.7</u>	5.0	5.2	4.9
43.	Lechmere Square	<u>4.8</u>	4.8	<u>4.8</u>	4.7
44.	Nashua Street and Martha Rd.	<u>6.5</u>	6.2	6.2	5.9
45.	Cambridge & New Chardon Streets	<u>7.0</u>	6.6	6.3	6.5
46.	Cambridge & New Sudbury Streets	<u>7.1</u>	6.2	6.3	4.6
47.	Charles Circle	5.5	5.4	<u>5.6</u>	5.8
48.	Broadway & Third Street	3.5	3.5	3.5	3.5
49.	Sullivan Square	<u>5.1</u>	<u>5.1</u>	4.9	4.9

- Notes:
1. Analysis sites numbered 1 to 34 coincide with numbering utilized in the 1990 FSEIS/R, locations 40 - 49 are new sites.
 2. CO 8-hour AAQS is 9 ppm.
 3. Values include 8-hour CO background level of 2.4 ppm.
 4. Underline indicates greatest impacts.

Source: Bechtel/Parsons Brinckerhoff

Table 8-11

ESTIMATED 1-HOUR WORST CASE CO LEVELS INCLUDING CONTRIBUTIONS FROM VENTILATION BUILDINGS

YEAR 2010
(ppm)

No.	Location	Scheme Z	8.1D Mod5	NRT	RRT
1.	Gilmore Bridge & O'Brien Highway	12.2	<u>12.7</u>	<u>12.7</u>	12.5
2.	City Square	<u>12.1</u>	9.2	8.8	<u>9.0</u>
3.	Leverett Circle	<u>10.9</u>	<u>11.8</u>	9.8	<u>9.8</u>
4.	Causeway/Merrimac/Lomasney	<u>12.9</u>	12.5	12.2	12.3
5.	Causeway & Haverhill Rd.	9.7	<u>10.0</u>	9.8	9.8
6.	Causeway & Beverly Rd.	9.7	<u>9.8</u>	9.3	9.3
7.	North Washington & Commercial (Keeny Sq.)	<u>13.6</u>	13.0	13.2	13.0
8.	New Sudbury & Congress Streets	<u>10.1</u>	10.0	9.8	9.8
9.	New Chardon/Haverhill/North Washington	10.6	10.2	<u>10.7</u>	10.0
10.	New Chardon/Stillman/North Washington	10.1	11.2	11.2	<u>11.5</u>
14.	Congress & State Streets	8.4	<u>8.7</u>	8.4	8.1
15.	State St. & Surface Rd.	9.7	<u>9.8</u>	9.7	<u>9.8</u>
34.	Cambridge & Staniford Streets	<u>12.2</u>	12.2	11.7	11.3
40.	New Rutherford/C-L @ Bunker Hill College	9.7	<u>10.3</u>	9.8	9.8
41.	New Rutherford & Gilmore Bridge	<u>9.9</u>	9.3	9.3	<u>9.0</u>
42.	New Rutherford/BS & G	<u>12.1</u>	9.7	9.7	9.0
43.	Lechmere Square	8.4	8.4	<u>9.8</u>	<u>8.5</u>
44.	Nashua Street and Martha Rd.	11.7	11.3	<u>11.2</u>	<u>12.0</u>
45.	Cambridge & New Chardon Streets	<u>11.9</u>	11.2	10.9	11.2
46.	Cambridge & New Sudbury Streets	<u>12.2</u>	11.3	11.2	11.3
47.	Charles Circle	9.9	10.0	10.0	10.0
48.	Broadway & Third Street	6.4	6.3	<u>6.5</u>	<u>6.5</u>
49.	Sullivan Square	<u>8.9</u>	8.3	8.5	8.5

- Notes:
1. Analysis sites numbered 1 to 34 coincide with numbering utilized in the 1990 FSEIS/R, locations 40 - 49 are new sites.
 2. CO 1-hour AAQS is 35 ppm.
 3. Values include 1-hour CO background level of 4.4 ppm.
 4. Underline indicates greatest impacts.

Source: Bechtel/Parsons Brinckerhoff

Table 8-12

**ESTIMATED 8-HOUR WORST CASE CO LEVELS INCLUDING CONTRIBUTIONS FROM VENTILATION BUILDINGS
YEAR 2010
(ppm)**

No.	Location	Scheme Z	8.1D Mod5	NRT	RRT
1.	Gilmore Bridge & O'Brien Highway	7.3	<u>7.5</u>	<u>7.5</u>	7.4
2.	City Square	<u>7.2</u>	5.6	6.3	5.3
3.	Leverett Circle	6.2	7.0	<u>5.8</u>	5.5
4.	Causeway/Merrimac/Lomasney	<u>7.7</u>	7.5	7.2	7.3
5.	Causeway & Haverhill Rd.	5.8	<u>5.9</u>	5.0	5.8
6.	Causeway & Beverly Rd.	5.8	<u>5.9</u>	5.5	5.9
7.	North Washington & Commercial (Keeny Sq.)	<u>8.1</u>	7.0	7.8	7.4
8.	New Sudbury & Congress Streets	<u>6.0</u>	<u>6.0</u>	5.5	5.9
9.	New Chardon/Haverhill/North Washington	<u>6.3</u>	6.1	<u>6.3</u>	5.9
10.	New Chardon/Stillman/North Washington	6.0	6.7	6.6	<u>6.8</u>
14.	Congress & State Streets	5.0	<u>5.2</u>	5.0	7.3
15.	State St. & Surface Rd.	5.9	<u>6.0</u>	5.0	6.6
34.	Cambridge & Staniford Streets	<u>7.3</u>	7.3	7.0	7.1
40.	New Rutherford/C-L @ Bunker Hill College	5.8	<u>6.2</u>	5.9	5.9
41.	New Rutherford & Gilmore Bridge	<u>5.9</u>	5.6	6.6	5.6
42.	New Rutherford/BS & G	<u>6.0</u>	5.8	5.8	5.9
43.	Lechmere Square	5.0	5.0	5.0	<u>5.1</u>
44.	Nashua Street and Martha Rd.	<u>7.1</u>	7.3	6.3	<u>7.1</u>
45.	Cambridge & New Chardon Streets	<u>7.1</u>	6.7	6.5	6.6
46.	Cambridge & New Sudbury Streets	<u>7.3</u>	6.7	6.6	6.7
47.	Charles Circle	5.9	<u>6.0</u>	5.9	5.9
48.	Broadway & Third Street	3.8	3.8	3.8	3.8
49.	Sullivan Square	<u>5.3</u>	5.0	5.0	5.0

- Notes:
1. Analysis sites numbered 1 to 34 coincide with numbering utilized in the 1990 FSEIS/R, locations 40 - 49 are new sites.
 2. CO 8-hour AAQS is 9 ppm.
 3. Values include 8-hour CO background level of 2.6 ppm.
 4. Underline indicates greatest impacts.

Source: Bechtel/Parsons Brinckerhoff

Appendix C: 404(b)(1)

Appendix C

404(b)(1) GUIDELINES

1 INTRODUCTION

All four of the designs for the portion of the Central Artery/Tunnel Project in the Project subarea called the Area North of Causeway Street in Boston, Massachusetts, involve dredging and filling in the Charles River and Millers River. An application for a permit to conduct these activities has been submitted to the U.S. Army Corps of Engineers (USACE) pursuant to Section 404 of the Clean Water Act. A public notice will be issued, requesting comments on the proposed work. As a part of its review of the permit application, USACE will apply guidelines published at 40 CFR Part 230, usually referred to as 404(b)(1) Guidelines. The purpose of these guidelines is "to restore and maintain the chemical, physical, and biological integrity of waters of the United States through the control of discharges of dredged or fill material." A Section 404 permit cannot be issued by USACE unless it is determined that the proposed activity complies with these guidelines. The Guidelines prohibit discharges of dredged or fill material into Federally regulated waters and wetlands where practicable alternatives exist which have less adverse impact on the aquatic ecosystem and which do not have other significant adverse environmental consequences. Accordingly, the USACE will evaluate the alternatives with respect to their impacts on the aquatic ecosystem. Once compliance is clearly demonstrated, the USACE can proceed with an evaluation of public interest. This evaluation examines many broad-ranging factors and weighs and balances beneficial and adverse aspects of the Project. The organization of this appendix and the terminology used in it are intended to address the requirements of the 404(b)(1) Guidelines.

1.1 Project Purpose

The Project is to be built by the Massachusetts Highway Department (MHD), and is being funded by the Federal Highway Administration (FHWA) and the Commonwealth of Massachusetts. The need for the Project has long been recognized by public transportation agencies, the citizens who live and work in the corridors that will be improved, and the motoring public who use the existing facilities. The overall purpose and need for the Project is stated in detail in Chapter 1 of this DSEIS/R.

The purpose of the Project in the Area North of Causeway Street is to link regional highway facilities on the south side of the Charles River (the Central Artery, Storrow Drive, and the Callahan/Sumner Tunnels) to essential regional connections on the north side of the Charles River (I-93 northbound and the Tobin Bridge/Route 1), and to complete all necessary local connections to these facilities. The Project must cross waterways in this area, namely the Charles River and Millers River, to provide the interconnecting highway links that are essential to achieve this purpose. Since accommodating the 14 traffic movements in the I-93/Route 1 interchange requires access, proximity to and siting within a special aquatic site (wetlands), the Project's basic purpose is water dependent.

1.2 Purpose Of Appendix

The purpose of this appendix is to provide background information to USACE for use in evaluating the Project's compliance with the 404(b)(1) Guidelines. This appendix is intended to facilitate the review of the application for a permit to discharge dredged or fill material into waters of the United States, including wetlands.

2 ALTERNATIVES

Four designs for the Charles River Crossing are evaluated in this DSEIS/R. These include Alternative 8.1D Mod 5, as described in the 1992 Notice of Project Change (NPC) and two subsequent designs based on it, the Reduced River-Tunnel Alternative and the Non-River-Tunnel Alternative. These three alternatives and Scheme Z, the Proposed Action in the 1991 FSEIS/R, are analyzed in this DSEIS/R.

The 1991 FSEIS/R described the Proposed Action in this Project subarea as an all-viaduct option (Scheme Z). In February 1991, a Bridge Design Review Committee (BDRC) was established by the Massachusetts Secretary of Transportation and Construction. The Committee was created to comply with the Final Certificate of the 1991 FSEIR of the Massachusetts Secretary of Environmental Affairs (EOEA). The BDRC assessed a broad spectrum of designs in the Area North of Causeway Street with support by the Executive Office of Transportation and Construction (EOTC), by MHD's management consultant, and by independent experts. Over 20 alternatives were considered which were narrowed to three Committee Improvement Packages (CIP).

These three CIPs have common key features which address the BDRC's objectives, "to reduce the environmental and aesthetic impacts of the crossing." Most instrumental towards achieving these objectives are the land-based tunnels connecting Storrow Drive with the Central Artery (I-93), reducing local traffic impacts. In addition, these CIPs are based on bridge concepts which are designed to avoid parallel bridges with inconsistent profiles, to reduce the overall bridge width, and to simplify the complexity of Scheme Z, reducing the number of supporting columns in the Charles River and the visual clutter of columns on land.

Following a unanimous vote in June 1992 by the BDRC, MHD's management consultant continued design analysis of the BDRC-favored CIP 8.1. An NPC was filed with the Massachusetts EOEA on September 30, 1992, describing the revised Charles River Crossing and its potential impacts, known as Scheme 8.1D Mod 5 in that document.

Concerns were raised by regulatory agencies in comments on the NPC that there may be other alignment designs which may have fewer impacts to water and wetland resource areas. Therefore, two additional design alternatives to Alternative 8.1D Mod 5 of the NPC were developed: a Reduced River-Tunnel Alternative and a Non-River-Tunnel Alternative. The FHWA Scope of Work for this DSEIS and the EOEA Certificate on the NPC required evaluation of these three alternatives to Scheme Z.

What follows is an evaluation of Scheme Z and the three new design alternatives according to the Section 404(b)(1) Guidelines.

3 POTENTIAL IMPACT ON PHYSICAL AND CHEMICAL CHARACTERISTICS

3.1 Substrate

3.1.2 Existing Conditions

The substrate in the Charles River consists predominantly of organic mud and silts, with lesser amounts of sand and clay. During 1988, sediment samples were collected from the Charles River near the area where potential bridge piers would be constructed. These samples were tested for bulk chemical quality and extraction procedure (EP) toxicity. The surface sediments were found to be highly contaminated with metals. The most notable elements are cadmium, chromium, copper, lead, mercury, and zinc. Surface

sediments also contained high concentrations of petroleum hydrocarbons and PCBs. PCBs were found to be present at concentrations less than 50 mg/kg indicating they are not hazardous at this concentration. Improved sediment quality was noted with increasing sediment depth, although mercury was still found at high levels.

The results of the EP toxicity tests indicate the leachate was well within (10 to 100 times lower than) the maximum Environmental Protection Agency (EPA) contaminant level.

The bottom of the Millers River consists of more than 10 feet of organic oily muds. Sediment quality data for the Millers River indicate that the sediments are contaminated with petroleum hydrocarbons (0.2 to 1.2 percent), arsenic, chromium, copper, lead, mercury, and zinc.

3.1.3 Effects

The preliminary construction plan indicates the following activities; these activities may be refined depending on the preferred alternative selected and will be detailed in the Supportive Engineering Report of the FSEIS/R.

The proposed pier installation will be constructed inside cofferdams. Sheet pile will be driven well below the river bottom, loosening bottom sediments in the immediate area. Following dewatering, a clamshell will dredge out the material within the sheet pile cofferdam down to a level which is suitable for the pier foundation. Options include driving piles or drilling caissons into bedrock to establish a firm foundation. Then concrete will be poured into the cofferdam, filling it either to a point just below the existing mudline or to a point above the surface of the water. Once that concrete foundation has set, concrete forms for the piers will be installed on top of the foundation. Concrete will be poured and allowed to set. The sheet pile will be removed down to the top of the foundation. Removing it completely would be difficult for the contractor, stir up bottom sediments, and serve no useful purpose. Demolition and removal of the existing I-93 bridge will involve removal of all but one of the piers down to the mudline. Bottom sediments will be disturbed during this activity. The existing so called "banana" pier will remain for hydraulic reasons, originally installed to facilitate MDC dam flood control pumping operations.

The effect of the installation of the new piers and the removal of the I-93 piers in the Charles River will result in a net gain of river bottom. Less than 2 percent of the Millers River will be affected by pier placement. No change to the substrate in either river other than pier installation will result from Scheme Z. For the new alternatives, filling of approximately one-third of the northern end of the Millers River will occur for an at-grade intersection. Alternative 8.1D Mod 5 and the Reduced River-Tunnel Alternative will have temporary impacts to the Charles and Millers Rivers due to construction of the tunnels.

3.2 Suspended Particulates And Turbidity

3.2.1 Existing Conditions

The Charles River contains moderate suspended solids with a range of 6.8 to 7.2 mg/l. Turbidity levels range from 1.0 to 1.5 nephelometer turbidity units (NTU). Although the suspended solids concentrations are at a moderate range, water color has been found to be the main determining factor in water clarity. The Charles River has high color values and the water is noticeably amber to dark brown.

Suspended particulates and turbidity, as measured by total suspended solids concentrations, vary in the Millers River. Suspended solids are highest in the upper end of the river closer to the main storm sewer

inlets and the wash station for Boston Sand & Gravel (BSG). Water clarity is poor and prevents visibility to the river bottom, which is at a maximum depth of 3 feet.

3.2.2 Effects

In all four designs, all the fill will be contained within sheet pile cofferdams which will minimize turbidity. As a result of sheet pile driving, however, some turbidity can be expected. To minimize impacts, the contractor will be required to use silt curtains and monitor water quality on a regular basis.

The 8.1D Mod 5 and the Reduced River-Tunnel Alternatives will have additional temporary impacts due to the construction of the tunnels. Dredging operations will be accomplished with necessary turbidity controls such as closed clamshell buckets and silt curtains to confine suspended particles to the dredge area. A water quality monitoring program will be ongoing throughout construction, and mitigation measures will be instituted to ensure water quality will not be affected during construction.

The foundation material for the tunnels will be deposited at the bottom of the trench and will not travel through the water column. The backfill and cover material, consisting of clean crushed rock and granular material, also will be placed within the dredged trench. The top of the tunnel will be protected with a layer of crushed rock. Since the fill material contains little fines and is placed on the bottom, minimal turbidity will be created. Upon completion of the Project, levels of suspended particulates and turbidity are expected to return to normal levels.

3.3 Water

3.3.1 Current Patterns, Water Circulation, And Fluctuations: Existing Conditions

Charles River. The lower Charles River is between the old Charles River dam (constructed in 1910) at the Boston Museum of Science and the new Charles River dam (constructed in 1976), which is also known as the Colonel Gridley Locks. Following construction of the new dam and locks, tidal fluctuations were eliminated within the lower Charles River. The locks are used to permit vessels to move between the Charles River and the Boston Inner Harbor.

The lower Charles River is approximately 2,200 feet long. Width varies, but averages 450 feet. The width on the west side of the new dam is approximately 600 feet, narrowing to about 375 feet beneath the MBTA commuter railroad bridge, and increasing to approximately 450 feet west of the railroad bridge. The greatest width (1,200 feet) occurs immediately east of the old dam. Average water depth is approximately 17 feet, with a maximum depth of 24 feet between the railroad bridge and the new dam.

Fresh water from the Charles River drainage basin flows continuously through the spillways and locks of both the old and new dams before entering the tidally influenced Boston Inner Harbor. The mean annual flow from the river is approximately 450 cubic feet per second (cfs), and the 7-day, 10-year low flow is approximately 22 cfs. The effect of the new dam is to maintain constant water depth in the river, given the varying flow.

The new Charles River dam is a part of the flood protection system for the low-lying areas of the Boston region. During high tide and storm conditions, the water elevation of the Harbor can be higher than that of the Charles River Basin on the other side of the dam. In order to maintain the proper water elevation within the Basin, which is subject to the possibility of excess inflow from either direction, a pumping station was built, which includes six 1,400-cfs-capacity pumps. The pump station controls are set to maintain an elevation 2.35 feet above mean sea level. The reported 100-year flood elevation is 4.3 feet

above mean sea level. The currents and circulation in the Basin are determined entirely by the release rate from the Charles River dam. Currents are most likely unidirectional toward the dam and their velocity could average 1 foot per second. Velocity could be higher than 5 feet per second under flood conditions.

The piers of the Charles River bridge (part of the existing Central Artery) cross the flow path of the river just upstream of the pumping station. Still farther upstream, the Boston and Maine Railroad bridge (MBTA commuter railroad trestle) crosses the river, creating a left and right overbank due to the dense pilings underneath. The downstream flow between the overbanks results in a "jet" (concentration) of relatively high velocity flow, curved towards the north shore. This high-velocity jet approaches Pier A (the so-called reverse banana pier) of the Charles River bridge, causing a large separation region downstream of the pier. Pier A, however, is hydrodynamically streamlined in order to achieve a uniform flow rate into the pump station.

Millers River. The Millers River is a short (approximately 1,000 feet long) and shallow waterway on the north side of the lower Charles River near the new Charles River dam. It is separated from the lower Charles River by an earth dam and drains into the Charles River through two 84-inch culverts.

Drainage into the open portion of the Millers River at its upstream terminus is through three 48-inch storm sewers from a densely developed urban and industrial area, which includes adjacent railroad yards. The triple 48-inch storm sewer is severely plugged and currently provides very little flow into the Millers River. Although the Millers River originally extended beyond the current limits and was tidal, historic filling and construction of the new Charles River dam have altered the water course to its present size and type, converting it to a freshwater system. The Millers River has a drainage area of approximately 460 acres and a surface water area of 1.7 acres. The water depth was determined with a recording fathometer and the plots indicate a uniform maximum depth of 3 feet. The volume of the Millers River is, therefore, approximately 222,000 cubic feet.

The mean annual flow of the Millers River is 3 cfs while the mean annual flood is 55 cfs. The 7-day, 10-year low flow was determined to be less than 0.1 cfs. Based on existing information, it can be concluded that the local hydrology is driven primarily by surface waters. There is no evidence of groundwater input such as seeps or springs. Stormwater runoff is considered to be the main hydrologic contribution to the Millers River as well as the prominent factor in circulation, flushing, and dilution. Based on the volume and flow rates, the river has a mean daily flushing rate of 1.2, and during the 7-day, 10-year low flow the river shows no flushing activity.

Circulation in the Millers River is determined by wind blowing along the axis of the river and water flow in the Charles River. Given the small grain size of the sediment particles (90 percent of the particles are in the silt/clay range) in the surface muds and the depth of the sediments, the environment is strictly depositional and flows do not appear to exhibit any erosive potential.

Water level fluctuations are determined by the elevation of the Charles River. The culverts located at the Millers River outlet to the Charles River are approximately 900 feet upstream of the Charles River dam and flood control pumping station. Controls in the pump station are set such that pumping starts when the water level of the Charles River reaches the elevation of 2.35 feet above mean sea level. The 100-year flood elevation is reported to be 4.3 feet above mean sea level.

There is no evidence or information that the Millers River has any interaction with groundwater. The drainage basin is a heavily developed urban and industrial area which severely limits recharge. Without

appreciable recharge, the amount of groundwater discharge is limited. The till and clay which underlie the recent river deposits also serve to limit groundwater interaction.

Chemical Characteristics. The lower Charles River is Class B waters according to the Department of Environmental Protection, Division of Water Pollution Control (DEP/DWPC). Class B waters are designated for primary and secondary contact recreation, and as a habitat for fish, aquatic life, and wildlife.

The recent water quality data upstream of the new Charles River dam indicate that Class B water quality standards are not consistently met. DEP has designated the Charles River Basin above the new dam as nonsupport (NS), indicating that the standard is not met. According to DEP, the Charles River Basin's water quality problems are high fecal coliform counts and low dissolved oxygen concentration caused by combined sewer outfalls, urban runoff, and sediments.

DEP/DWPC has classified the Millers River as Class B. Since water quality data for the Millers River were not available, water samples were collected and analyzed in November 1989 for general water quality parameters and metals. The data indicate that portions of the river have dissolved oxygen below the Class B water quality standard of 5.0 mg/l. In addition, fecal coliform bacteria concentrations were high, exceeding the water quality standards. Hydrogen ion (pH) levels were within the Class B standard. Specific conductance and total dissolved solids concentrations indicated the water is fresh and not saline.

Salinity Gradient. The portions of the Charles and Millers Rivers which will be affected by the proposed Project are nontidal waters. The salinity in the area of the Charles River near the locks is variable due to the passage of salt water whenever the lock is opened. However, the DEP/DWPC water classification is for fresh water.

3.3.2 Effects

The four Project designs in the Charles River crossing area have been designed to avoid impacts to existing water circulation patterns. The surface elevation is controlled by the MDC at a downstream dam. Except during the temporary construction period, water quality, temperature, thermal stratification, currents, and circulation patterns should not change. The suspension of bottom sediments during construction may release some contaminants into the water. This temporary effect will not have any permanent effect on water quality.

4 POTENTIAL IMPACTS ON BIOLOGICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM

4.1 Threatened Or Endangered Species

There are no known threatened or endangered species of plants, fish, and/or animals within the Charles and Millers Rivers.

4.2 Fish, Crustaceans, Mollusks, And Other Aquatic Organisms

4.2.1 Existing Conditions

Aquatic Invertebrate Diversity And Abundance. The Charles River benthic community consists of pollution-tolerant worms. Sampling for benthic macroinvertebrates was conducted in the Millers River

during November 1989. Samples were collected in two locations. One sludge worm (*Tubifex tubifex*), was found indicating no diversity or abundance in the invertebrate community. Based on this information and the results of the bulk chemical sediment analyses, it can be concluded that the sediments are too contaminated to support a diverse invertebrate community.

Fisheries Diversity And Abundance. A warmwater fishery is present upstream of the new Charles River dam. During July 1981, the Massachusetts Department of Environmental Management (DEM), Division of Fisheries and Wildlife, conducted a fishery survey near the Boston University bridge. In order of abundance, the fish found in the sampling included golden shiners, white perch, alewife, pumpkinseed, yellow perch, white sucker, white catfish, northern pike, chain pickerel, and brown bullhead. Growth rate was reported to be excellent and the condition factor was comparable to the Statewide average. Some of these species are also likely to be found between the old and new dams.

Anadromous fish (seasonal migrating fish) that pass into the Charles River via the new dam include smelt, blueback herring, and alewives. The Charles River contains one of the largest alewife and herring runs in Massachusetts.

During November 1989, the Millers River was sampled for fish using electroshocking. Approximately one-third of the river was electrofished, including the end closer to the Charles River where dissolved oxygen levels may have been suitable for fish. No fish were found.

Shellfish Diversity And Abundance. There are no data on the presence of freshwater mussels in the proposed construction area. However, given the contamination levels of the sediments, it is unlikely that any mussels are to be found in the Charles River. Field investigations indicate that there are no shellfish in the Millers River.

4.2.2 Effects

The proposed Project involves the construction of bridge piers and tunnels (in two alternatives) which will not interfere with the passage of fish. Turbidity controls used during periods of construction and pier removal will confine the suspended particles to the construction area. Timing of the activities which have the potential to impact fish during their annual spawning period will be coordinated with State and Federal officials. No changes to water temperature or water quality will result from the completed Project.

The amount of direct sunlight on the water sheet will be reduced as a result of the I-93 bridge deck(s) in all four designs and it is likely that some fish may move to the open water shadowed areas. Vegetation in the shaded areas is likely to be adversely affected. Since the Millers River does not sustain fish habitat, there are no long-term impacts of filling to the existing fisheries.

4.3 Wildlife

4.3.1 Existing Conditions

Wildlife diversity and abundance on the Charles River is limited by the uniformity of available river habitat, i.e., lack of adequate vegetation, embayments, or bank diversity. Cormorants, however, have been observed feeding and resting in the area. A few ducks have been the only wildlife observed using the Millers River. Although a few species may use the river, surrounding land uses and poor water quality limit potential wildlife diversity or abundance.

4.3.2 Effects

All areas of fill will occur in the water and will not affect wildlife. The few ducks using the Charles River and Millers River and the cormorants in the Charles River will still have more than adequate space for their small numbers. Some permanent loss of *Phragmites australis* in the Millers River will occur due to construction and shading from proposed bridges and viaducts. However, the Millers River does not provide an extensive wildlife habitat.

5 POTENTIAL IMPACTS ON SPECIAL AQUATIC SITES

5.1 Sanctuaries And Refuges

The Charles and Millers Rivers are not designated as sanctuaries or refuges under Federal, State, or local laws.

5.2 Wetlands

Approximately 0.05 acre (2,175 square feet) of Federal wetlands were found on the riprap banks of the Charles River. These inland wetlands will not be affected by the proposed work except for shading from the completed bridge deck(s). Approximately 0.4 acre (17,600 square feet) of inland wetlands were found along the Millers River. For the alternatives, not for Scheme Z, about half of these wetlands will be filled for the access ramps. Some vegetation will be lost due to shading from the bridge and viaduct decks. Wetland replacement is not required since these wetlands provide minimal function.

5.3 Mudflats

The Charles River and Millers River are freshwater rivers with no tidal influence. Water levels are kept constant by releases from a downstream dam; consequently, mudflats do not exist.

5.4 Vegetated Shallows

The Charles River and Millers River contain wetland vegetation along certain portions of their banks, but no rooted aquatic vegetation was found during field review.

5.5 Coral Reefs

There are no coral reefs in the Project subarea.

5.6 Riffle And Pool Complexes

No known riffle and pool complexes exist within the Project subarea in the Charles and Millers Rivers.

6 POTENTIAL EFFECTS ON HUMAN USE CHARACTERISTICS

6.1 Municipal And Private Water Supplies

Within the lower Charles River and the proposed construction area, there are no known public or private water supply uses. There are no water supply uses of the Millers River for either public or private purposes. Consequently, the Project will have no effect on public or private water supply uses.

6.2 Recreational And Commercial Fisheries

During periods of sheet pile installation, tunnel construction and blasting, and removal of existing piers within the Charles River, turbidity will be monitored and controlled as necessary. Timing of these activities with regard to critical spawning periods in the Charles River will be coordinated with State and Federal agencies. Therefore, no adverse impacts to recreational or commercial fisheries are expected under any design. No fish have been found in the Millers River, and no shellfish have been found in either river.

6.3 Water-Related Recreation

During construction, speed and area restrictions on navigation in the lower Charles River may be imposed under any design in the interests of safety. These restrictions could include temporary closing of the river to boats for a short period of time. An appropriate plan will be coordinated with various agencies and river users to minimize construction impacts on recreational boating. Once completed, the Project will provide an improved setting for water-related recreation by enhancing parkland development opportunities in this area of the Charles River.

6.4 Aesthetics

The bridges are being designed to have the fewest possible number of piers within the rivers, and old bridge structures will be removed below the water line. Some shading of the water sheet will occur, but there should be no change in the visual quality of the river areas. Visual impacts are reduced from those caused by Scheme Z's loop ramps in all three new design alternatives.

6.5 Parks, National And Historical Monuments, National Seashores, Wilderness Area, Research Sites, And Similar Preserves

The Metropolitan District Commission (MDC) has for many years had a goal to extend the Esplanade on the north and south banks of the Charles River to connect to open spaces along the edge of Boston Harbor. As a result of a prior planning process, MHD has agreed to facilitate to the greatest extent possible the MDC's goals for future parkland acquisition and development of the land available after Project completion. The three new design alternatives substantially improve the extent to which the integrated parklands system can be successfully implemented. Following construction, landscaping and pathway improvements will be provided along the north and south banks of the Charles River throughout the Project alignment. For further details see the Section 4(f) Evaluation.

7 ACTIONS TO MINIMIZE ADVERSE EFFECTS

7.1 Actions Concerning The Location Of The Discharge

The proposed designs minimize the number of piers and fill in the rivers. The construction work and its resulting impacts will be confined by cofferdams and appropriate turbidity controls.

7.2 Actions Concerning The Materials To Be Discharged

Dredged material will be removed with appropriate controls and transported for disposal so as not to introduce suspended bottom sediments into the rivers. The fill material consists of poured concrete and granular fill. Appropriate turbidity control techniques will be used to minimize effects of the discharge.

7.3 Actions Controlling The Material After Discharge

Fill placed will be appropriately covered with granular material and riprap to minimize erosion.

7.4 Actions Affecting The Method Of Dispersion

Silt screens will be used to confine suspended particles during the driving of the steel sheet piles. The area to be dredged will be confined within cofferdams. The fill materials will not be dispersed, but confined to the cofferdams and concrete forms.

7.5 Actions Related To Technology

The methods of discharge and the equipment used have been chosen to minimize adverse environmental impacts. The contractor will be required contractually to maintain specified environmental standards.

7.6 Actions Affecting Plant And Animal Populations

Construction activities will be coordinated with Federal and State agencies to minimize effects on fish. Following construction, no significant changes in water current and circulation patterns will occur. Wetlands which will be lost as a result of the Project provide minimum functions to plant or animal populations.

7.7 Actions Affecting Human Use

Construction activity will take place over a 4-year period. Use by recreational boaters will continue, although some reductions in speed or area may be required for safety reasons. Bridge pier design and placement will take into account the need for tug and barge units to navigate through the bridge area with no obstructions.

Appendix D: Wetlands/Waterways

Appendix D

WETLANDS/WATERWAYS

MASSACHUSETTS WETLANDS

1 WETLANDS PROTECTION ACT (MA WPA)

Pursuant to the Massachusetts Wetlands Protection Act (MA WPA) (MGL Ch. 131 Sec. 40) and associated regulations (310 CMR 10.00 et seq.), the DEP and/or municipal Conservation Commissions have jurisdiction over activities in inland wetland resource areas. In addition, activities within a 100-foot setback (buffer zone) from Inland Banks and Bordering Vegetated Wetlands are regulated. The project activities proposed under each alternative and their relation to the state wetlands regulations are outlined in this section. None of the alternatives propose activities which would require variances from the wetlands regulations.

1.1 Affected Environment

General

The study area includes the portion of the Charles River upstream of the existing MDC dam and downstream of the old Charles River dam (now the location of the Science Museum and the O'Brien Highway) as well as the adjacent Millers River. The surrounding area is highly developed and urbanized, being occupied mostly by transportation and industrial uses. In the Charles River, the river banks consist mostly of vertical seawalls and sloped rubble or rip-rap banks and in the Millers River they are steep, and consist of mud and silt, rubble, and stone riprap. Vegetation along both Rivers is minimal; it is limited to narrow bands of successional weed species along portions of the river banks. Land adjacent to the Millers River are highly disturbed and public access to the area is limited. The Millers River has poor water quality.

1.1.1 Charles River

Hydrographic

Following construction of the new dam and locks in 1976, tidal fluctuations within the Lower Charles River were effectively eliminated. The locks are used to permit vessels to move between the Charles River and the Inner Harbor. Fresh water from the Charles River drainage basin flows continuously through the spillways and locks of both the old and new dams before entering the tidally influenced Boston Inner Harbor. The mean annual flow from the Charles River is approximately 450 cubic feet per second (cfs) and the 7-day, 10-year low flow is approximately 22 cfs. The new dam is operated to maintain constant water depth in the Charles River. The dam is part of the flood protection measures for the low-lying areas of the Boston region. During storm events a large pumping station located at the dam is activated to evacuate large volumes from the Charles River Basin to prevent flooding.

The banks are subject to flooding but as the water elevation is controlled by the Charles River dam, flooding does not overtop the banks. Furthermore, the banks, with a crest elevation of 107.5, presently provide over 5 vertical feet of freeboard above the normal water elevation maintained by the dam (102.4) and over 4 feet above the Mean Annual Flood elevation (103.5).

Water Quality

The water quality standard of the Lower Charles River is Class B, designated as an area for primary and secondary contact recreation, and as a habitat for fish, aquatic life and wildlife. However, the most

recent water quality data, available from the MDC, DEP and MWRA, suggest that Class B water quality standards are not consistently met. DEP has designated the Charles River Basin above the new dam as NS (nonsupport), indicating that the standard is not met. According to DEP, the Charles River Basin's water quality problems are high fecal coliform counts and low dissolved oxygen concentrations caused by CSOs, urban runoff, and sediments .

The Charles River contains moderate suspended solids with a range of 6.8 to 7.2 mg/l. Turbidity levels range from 1.0 to 1.5 nephelometer turbidity units (NTU). However, water color has been found to be the main determining factor in water clarity, more so than suspended solid concentrations. The Charles River has high color values, and the water is noticeably amber to dark brown.

Sediment Quality

The surface sediments of the Lower Charles River have been found to be highly contaminated with metals¹. The most notable elements are cadmium, chromium, copper, lead, mercury, and zinc. Surface sediments also contain high concentrations of petroleum hydrocarbons and polychlorinated biphenyls (PCBs). The benthic community contains only pollutant-tolerant worms.

The deeper substrates consist predominantly of organic mud and silts, with lesser amounts of sand and clay. A clear and rapid improvement in sediment quality was noted with increasing sediment depth, although mercury was still found at high levels deep into the sediment. The results of the EP toxicity tests indicate the sediment leachate was well within (10 to 100 times lower than) the maximum contaminant level allowed by the U.S. Environmental Protection Agency (EPA); thus the material would not be classified as a hazardous waste.

Fisheries

The Charles River contains an anadromous fish run which includes golden shiners, white perch, herring, and alewife; the alewife and river herring runs are among the largest in the Commonwealth. A fish ladder built in the Charles River Dam was constructed to allow fish passage between the river and Boston Harbor, however, this facility has not been working since about 1988 and the fish travel through the locks. Also, the Charles River supports a warm water fishery upstream of the old Charles River dam²; some of these species are likely to be found in the project area as well.

Species most common to the area of proposed construction are those that prefer low flow, deep water pools except during migratory periods when herring are the predominant species. The value of the deep water pool as fish habitat may be somewhat limited by the high biological and chemical oxygen demands reported for the Charles. Reduced oxygen concentrations and soft sediments lower the value of the basin as spawning habitat.

Wildlife Habitat

Disturbance from adjacent land uses as well as poor water quality of the river itself severely limits wildlife habitat suitability. No food or fiber production occurs in this resource area. Additionally, the area does not meet any mineral needs.

¹ Soil and Groundwater Quality Report (Report 6)

² A July 1981, fishery survey by the Massachusetts Division of Fisheries and Wildlife near the Boston University Bridge found (in order of abundance), golden shiners, white perch, alewife, pumpkinseed, yellow perch, white sucker, white catfish, northern pike, chain pickerel, and brown bulkhead. Growth rates were reported to be excellent, and the condition factor was comparable to Statewide average.

1.1.2 Millers River

Hydrographic

The Millers River is an inlet off of the Charles River, connecting to the Charles through two subsurface 84 inch culverts located approximately 900 feet upstream of the MDC dam/flood control pumping station. Because of the hydraulic connection, the water levels and other hydrologic and hydrographic conditions in the river are normally controlled by the conditions in the Charles River.

The river has an open water area of approximately 1.7 acres and a nearly uniform depth of 3 feet, corresponding to a total volume of approximately 220,000 cubic feet. The river functions largely as a drainage channel for a 1,000-acre drainage basin, with the main flow contributions from the river occurring during storm events. The mean annual flow in the river is approximately 3 cfs, resulting in a average annual flushing rate of about once per day. The 7-day, 10-year low flow is less than 0.1 cfs. Since the low flow rate is essentially zero, there is no flushing under this condition. The banks of the Millers River are subject to flooding but as the water elevation is controlled by the Charles River dam, flooding does not overtop the banks.

Water Quality

Like the Charles River, the Millers River is a Class B water body under state water quality regulations. Water sampling program indicates that portions of the river have dissolved oxygen that was below the Class B water quality standard of 5.0 mg/l for a warm water fishery. In addition, fecal coliform bacteria concentrations were high, exceeding the water quality standards. Hydrogen ion (pH) levels were within the Class B standard. Specific conductance and total dissolved solids concentrations indicated the water is fresh and not saline.

Unstabilized portions of the Millers River banks, particularly adjacent to the Boston Sand & Gravel Company property, are causing sedimentation of the river.

Sediment Quality

The river bottom consists of more than 10 feet of organic oily muds, indicating a depositional environment. Sampling has indicated that the sediments are heavily contaminated with petroleum derivatives. In addition, levels of dissolved oxygen in sediment samples from the Millers River are too low (0.8 to 8.8 mg/l) to support fish or other aquatic life. Sampling for benthic macro invertebrates was conducted during November 1989. One sludge worm (*Tubifex tubifex*) was found, indicating no diversity or abundance in the invertebrate community. Based on this information and the results of the bulk chemical sediment analyses, it can be concluded that the sediments are too contaminated to support a diverse invertebrate community.

Fisheries

During November 1989, the Millers River was sampled for fish using electroshocking techniques, an effective sampling method for fresh water environs. Approximately one-third of the river was electrofished, including the end closer to the Charles River where dissolved oxygen levels may have been suitable for fish. No fish were found. Reduced oxygen concentrations and soft sediments lower the value of the basin as spawning habitat. Also, field investigations have revealed that there are no shellfish in the Millers River.

Wildlife Habitat

There is almost no means of access by wildlife to the Millers River, as the river and its narrow fringe of vegetation are entirely surrounded by industrial land. Disturbance from adjacent land uses as well as poor water quality of the river itself severely limits wildlife habitat suitability. No food or fiber

production occurs in this resource area. Additionally, the area does not meet any mineral needs. Ducks have occasionally been seen in the water, but probably no other wildlife uses the river for its banks.

Vegetated Wetlands

The Millers River is nearly entirely surrounded by a narrow band (1 to 5 feet wide) of vegetated wetlands as defined by Federal regulations. Delineation by the Corps of Engineers method using vegetation, soils and hydrology has established that the land surrounding the river contains wetlands at an elevation of about 104 feet. Approximately 17,600 square feet of federally-defined wetlands surround the Millers River. The dominant plant of these wetlands is common reed, *Phragmites australis*, an introduced plant with little wildlife habitat value.

Banks

The banks of the river contain a narrow band (1 to 5 feet) of vegetation along the perimeter of the river however, uplands immediately surrounding the bank are generally unvegetated. Minimal wildlife was observed in the wetland area and is limited to a few songbird sightings. No signs of other birds, mammals, amphibians, or reptiles have been observed.

1.2 WETLAND RESOURCE AREA DELINEATIONS

The following discussion enumerates and defines each wetland resource area located in and adjacent to the Millers and Charles Rivers in Boston and Cambridge. The state wetland resource areas consist of the following categories: Banks; Bordering Vegetated Wetlands; Land Under Water; and Land Subject to Flooding, all of which occur within the project limits. The Charles River also contains an anadromous fish stream (a coastal wetland resource area).

1.2.1 Delineations and Description

The definitions of the above listed coastal and inland wetland resource areas are provided below.

Bordering Vegetated Wetlands (BVW). Bordering Vegetated Wetlands are freshwater wetlands which border on creeks rivers, streams, ponds and lakes where soils are typically saturated and the topography is low and flat.

Land Under Water. Land Under Water includes all land below the Mean Annual Low Flow level (MALF = el. 102.4³ for Charles and Millers Rivers).

Inland Bank. Inland Banks are those landforms or man-made structures (excluding structures surrounded by water) which abut and confine the water-bodies and lie between Mean Annual Low Flow level (MALF = el. 102.4) and Mean Annual Flood level (MAFL = el. 103.5).

Bordering Land Subject to Flooding.

Bordering Lands Subject to Flooding are those areas which lie between Mean Annual Flood Level (MAFL = el. 103.5 and the 100-yr flood level, el. 104.3).

³

Note: Datum for project elevations is 100 feet below the National Geodetic Vertical Datum of 1929 (NGVD), or mean sea level. Therefore elevation 104.0 equals 4.0 feet NGVD.

Buffer Zone. The Buffer Zone includes all land within 100 feet of the Inland Bank and BVW resource areas in the Charles and Millers Rivers.

1.2.2 Methodology

The state wetland resource areas were delineated in accordance with the definitions as outlined in 310 CMR 310 10.00 and, except for BVW, as described above according to elevation. There are three small areas on the west side of the Millers River which qualify as BVW as they contain over 50% wetland vegetation, are low and flat and have annually saturated soils. There are no BVW associated with the Charles River.

1.2.3 Presumptions of Significance and Rebuttals to Presumptions

Bordering Vegetated Wetlands (BVW). The BVW along of the Millers River consists of three discrete patches of vegetation which total 180 s.f. On the west side, there are two small bands of BVW, one which is 35 s.f. and one which is 40 s.f. The remaining area of BVW is located at the southern tip of the River and comprises 105 s.f.

Presumptions of Significance: BVW's are likely to be significant to public or private water supply, to ground water supply, to flood control, to storm damage prevention, to the prevention of pollution and to the protection of fisheries and wildlife habitat. In the case of the project area BVW's, the presumptions of significance apply only for the prevention of pollution and the significance is very low.

Rebuttal of presumptions: Both the minimal size and the location of these wetlands in a degraded environment minimize any functional significance they may have to the interests of the Wetlands Protection Act. The BVW adjacent to the Millers River is not significant to public or private water supply or ground water supply, to flood control or to the protection of fisheries and wildlife habitat.

Public/Private Water Supply

There are no adjacent wells in this area and BVW's don't contribute to groundwater recharge/dischARGE. There are no known surface water users in this area.

Groundwater Supply

Both waterbodies have outlets, hydrology is driven by surface water, neither is perched, both are located at the base of a watershed and the wetlands are situated on fill material, In addition, the hydrology is primarily driven by surface waters and the Millers River contributes minimal base flows to the down gradient Charles River.

Flood control

The performance standards do not apply to the Charles and Millers Rivers as these waterbodies are not significant to flood storage or storm damage prevention (See Bordering Land Subject to Flooding below).

Protection of Fisheries and Wildlife Habitat

There is no fish life in the Millers River and thus, it is not significant to fisheries. Wildlife habitat needs include feeding, nesting, shelter, resting and rearing. Generally, only vegetated wetlands with high vegetative diversity and those which are least one acre in size are considered to provide significant wildlife habitat. Due to minimal evidence of organisms, poor water quality and limited food supply, the Millers River serves a minimal wildlife habitat function. There are no endangered species in or adjacent to the Millers River.

Prevention of Pollution

The only presumption of significance for which the BVW could arguably qualify is the prevention of pollution. However, the significance is very minor. These wetlands areas consist of low quality vegetation (primarily Phragmites) and they are sparse and isolated providing no real system of pollution attenuation.

Hence, the BVW in the Millers River is significant only to the prevention of pollution and the significance is minor.

Banks.

Presumptions of Significance: When a project proposes to alter, or fill a Bank, these areas are presumed to be significant to public or private water supply, to ground water supply, to flood control, to storm damage prevention, to the prevention of pollution and to the protection of fisheries and wildlife habitat.

Rebuttal of Presumptions: The banks adjacent to the Millers River and the Charles Rivers are significant to some, but not all of the presumed functions. The banks do not provide breeding habitat, escape cover and food for fisheries. Further, the banks provide minimal wildlife function. The banks of the Charles River are not significant to the prevention of pollution as they are not vegetated. The Millers River is not significant to the protection of fisheries habitat. There are no fish in the Millers River, thus, the banks do not serve to protect fisheries habitat by providing food, breeding habitat and cover for fish. Both water bodies are not significant to public or private water supply, ground water supply, flood control, storm damage prevention, or the protection of wildlife habitat (see discussion under BVW above).

Banks in the Millers River are significant to the prevention of pollution due to the presence of vegetation and banks in the Charles River are also significant to the protection of fisheries habitat because they abut an anadromous fish run.

Land Under Water.

Presumptions of Significance: Land under water bodies and waterways is likely to be significant to public and private water supply, to ground water supply, to flood control, to storm damage prevention to prevention of pollution and to protection of fisheries and wildlife habitat.

Rebuttal of Presumptions: LUW in the Charles River and Millers River is significant to some, but not all of the presumed functions. The Millers River and the Charles River have no important wildlife habitat. No rooted or submerged vegetation is present. Because neither the Millers nor the Charles River have been found to provide important wildlife habitat functions, the standards do not apply. The Millers River bottom has a degraded quality. A benthic survey of the Millers River conducted as part of the 1991 FSEIR/S, revealed the presence of a single individual pollutant-tolerant worm. The shallow portions of the land under water along the Charles River, where wildlife may burrow tunnels, consist of rip-rap areas generally impervious to tunneling. The Millers River is not significant to the protection of fisheries habitat (see discussion under BVW above and BLSF below) and both water bodies are not significant to public or private water supply, ground water supply, flood control, storm damage prevention or the protection of wildlife habitat (see discussion under BVW above).

Hence LUW in the Millers and Charles Rivers is significant to the prevention of pollution and the Charles River is also significant to the protection of fisheries habitat.

Bordering Land Subject to Flooding.

Presumptions of Significance: Bordering Lands Subject to Flooding are likely to be significant to flood control and storm damage prevention.

Neither the Charles River nor the Millers River are significant for flood control and storm damage prevention.

Rebuttal of Presumptions: While the Charles River provides an artificially controlled flood storage function, the significance of flood control and storm damage prevention in both waterbodies is of low to no significance because the lower Charles River basin is hydraulically regulated by the large pumping station located at the new Charles River dam and thus, the pumping station can easily handle any theoretical flood storage reduction.

According to 310 CMR, 10.57(2)(a), Bordering Land Subject to Flooding is considered to be an area with a "low, flat topography adjacent to and inundated by flood waters rising from creeks, rivers, streams, ponds or lakes." The topography and location are critical elements to the protection of interests discussed in 310 CMR 10.57(1)(a), which states that this land area is important for temporary storage for flood water. During peak run-off periods, flood waters are both retained and detained by the Bordering Land Subject to Flooding. Adjacent land to both the Charles River and the Millers River does not meet the criteria of low, flat topography. The Charles River Lower Basin (between the new and old dams) banks are steep banks with slopes ranging from very small to vertical walls in some areas. The Millers River has very steep slopes continuously throughout the circumference. Based solely on the low and flat slope criteria, the Charles River Lower Basin and the Millers River do not contain areas which qualify as Bordering Land Subject to Flooding.

Furthermore, following the construction of the new dam and locks in 1976, tidal fluctuations within the Lower Charles River were effectively eliminated. The locks are used to permit vessels to move between the Charles River and the Inner Harbor. Fresh water from the Charles River drainage basin flows continuously through the spillways and locks of both the old and new dams before entering the tidally influenced Boston Inner Harbor. The new dam is operated to maintain constant water depth in the Charles River and is part of the flood protection measures for the low-lying areas of the Boston region. During storm events a large pumping station located at the dam is activated to evacuate large volumes from the Charles River Basin to prevent flooding.

While the banks are subject to flooding, the water elevation is controlled by the Charles River Dam. Thus, flooding does not overtop the banks. The Dam keeps the water level at elevation 102.4 ft., and the "top of the bank" is at 103.5, a difference of 1.1 feet. The first break in the slope (point at which flooding would occur) is actually at elevation 107.5 ft, roughly yielding a volume of 56,000 cubic feet of water between the two dams and the Millers River for potential flood storage. The pumps at the Dam are operated when the water level is at 102.7 ft, two inches above the usually maintained level. Based on FEMA's Flood Insurance Study (Nov. 1990), the stillwater elevation for a 500-year flood event is 106.0 ft. for the Charles River Basin, immediately upstream of the new Charles River Dam.

During extreme storm events the Charles River Dam is able to regulate the water level at the Charles River such that the water level never rises above the 100-year flood plain. The Millers River water level is regulated by the Charles River Dam via two subsurface 84-inch culverts that allow flow into the Charles River, therefore, the Millers River by itself does not serve any flood control purpose. Flood storage capacity lost due to fill from any of the alternative crossings impacting the Millers River would be offset by additional spillage at the Charles River Dam.

According to the Charles River Dam manager, the Charles River is drained-off by gravity at the Charles River Dam twice a day (during low tides) depending on the water level for a period of 5 to 6 hours. If both sluice gates are utilized, a maximum flow of 2,200 cfs can be obtained. Sometimes during storms or spring floods, a total of six pumps at the dam can be operated to control flooding. Each pump has a capacity of 640,000 gallons per minute or 3,780,000 gallons per minute (roughly 8,400 cfs) for the six pumps. Currently, the mean annual flow from the Charles River is approximately 450 cfs and the 7-day, 10 year low flow is approximately 22 cfs. The gates currently operate at 2% of their capacity if just the gates are in operation. Theoretically, if both the gates and the pumps were to be in full operation, there would be a total flow capacity of 10,600 cfs. If both the gates and pumps are considered in operation, they currently operate at less than 1% of their combined capacity.

Hence, neither the Millers River nor the Charles River are significant to flood control and storm damage prevention.

1.3 CONFORMANCE WITH PERFORMANCE STANDARDS

The following discussion quantifies the impacts to the state wetland resource areas and provides an analysis of how the project meets the applicable performance standards outlined in the state wetland regulations. Table 1 represents temporary construction impacts, and Table 2 represents permanent impacts.

Figures of the Proposed Alternatives are found in the Section 4.5.1 and show the areas of proposed permanent alteration in each waterway.

1.3.1 Exceptions for water-dependent uses

The Certificate issued by the Secretary of Environmental Affairs on the 1990 DSEIS/R concludes that the three crossings proposed by the Central Artery/Tunnel project are water dependent. This conclusion has a bearing on the application of performance standards in both the coastal and inland wetland regulations.

Both the Charles River and the Millers River are classified as inland wetlands and activities are proposed which would result in temporary or permanent impacts to these wetland resource areas. Section 10.53(3)(l) establishes water dependent uses as limited projects in inland wetlands. The performance standards for each resource area, therefore, do not have to be met except as follows: if any other resource area is found to be significant to flood control or prevention of storm damage, the performance standards must be met for those interests; and finally, adverse impacts from such work in any other resource area shall be minimized in relation to the statutory interests for which that resource area is found to be significant. Because the Charles and Millers Rivers are not significant to flood storage or prevention of storm damage, the only performance standards which apply are those related to Bordering Vegetated Wetlands.

1.3.2 Activities Proposed In Each Resource Area And Conformance With Performance Standard

1.3.2(a) Bordering Vegetated Wetlands (BVW)

There are no BVW in the Charles River and only 180 sf of BVW associated with the Millers River. The areas of BVW located along the Millers River do not serve any significant function in regards to the presumptions of significance outlined in the regulations. The BVW on the westerly sides of the river is down gradient of the Boston Sand and Gravel operation and approximately 75 sf are growing on fill

Table 1

TEMPORARY IMPACTS TO STATE WETLAND RESOURCE AREAS

	Scheme Z ²	Alternatives			
		8.1D Mod 5 ³	Reduced River-Tunnel	Non-River Tunnel	
Charles River					
bordering vegetated wetland (acres)	N/A	N/A	N/A	N/A	
banks (linear feet)	100	660	620	90	
land under water (acres)	0.40	1.4	1.4	0.20	
land subject to flooding (acres) ¹	N/A	N/A	N/A	N/A	
Millers River					
bordering vegetated wetland (acres)	0	0.0010	0.002	0	
banks (linear feet)	140	390	380	100	
land under water (acres)	0.30	0.40	0.04	0.01	
land subject to flooding (acres)	0.02	0.02	0.04	0.010	

¹ Presumptions of significance for this do not apply.

² The impacts have been recalculated to reflect current pier dimension and construction methods for the Millers River, thus differing from those included in the 1991 FSEIS/R.

³ The impacts have been recalculated to reflect current construction methods, thus differing from those included in the Notice of Project Change.

Table 2
PERMANENT IMPACTS TO STATE WETLAND RESOURCE AREAS

Alternative	Bordering Vegetated Wetland (acres)	Banks (linear feet)	Land Under Water	Land Subject To Flooding ¹
Millers River				
Scheme Z ²	0	40	0.01	0.01
8.1D Mod 5	0	1,200	1.1	0.05
Reduced River-Tunnel	0	1,200	1.1	0.05
Non-River-Tunnel	0	1,220	1.1	0.05
Charles River				
Scheme Z	N/A	10	0.10	N/A
8.1D Mod 5	N/A	0	0.01	N/A
Reduced River-Tunnel	N/A	20	0.02	N/A
Non-River-Tunnel	N/A	20	0.01	N/A

¹ Presumptions of significance for this do not apply.

² The impacts have been recalculated to reflect current pier dimensions and construction methods for the Millers River, thus differing from those included in the 1991 FSEIS/R.

which has encroached into the river over time. There is no permanent alteration to BVW, thus performance standards are met.

1.3.2(b) Banks

Inland Banks are found on the Charles River and the Millers River. Activities are proposed under each alternative which would result in temporary and permanent impact to the banks and are shown on Tables 1 and 2. These activities include the construction of footings and the placement of piers to support the I-93 bridges and associated ramps. In addition, filling of the northern portion of the Millers River is required under all alternatives except Scheme Z to accommodate access ramps to and from the Millers River crossings. Under Scheme Z, the banks will be restored to their original condition and the physical stability and water carrying capacity of the banks of the Charles River and the Millers River will not be reduced after the Project is completed. Under all other schemes, the banks of the Charles River will be restored to their original condition; however, the banks in the northern portion of the Millers River will be lost as a result of the filling required for the access ramps.

The wetland interests for which the banks have some significance pertain to pollution prevention on the Millers River and fisheries protection on the Charles River. The significance of this resource area for flood control prevention of storm damage has been rebutted, therefore the performance standards do not apply. Nevertheless, the proposed activities on the banks in the Charles River may perform in terms of fisheries and wildlife habitat will be replaced by the reconstructed banks. The proposed activities in the Millers River will affect the physical stability of the bank through the removal of different amounts of bank as a result of filling in all alternatives except for Scheme Z. Scheme Z does alter 40 lf of bank; however, the stability of the bank will be improved upon completion.

1.3.2(c) Land Under Water

There are also temporary and permanent activities which will alter land under waterbodies in the Charles and Millers Rivers. These activities under each alternative are presented in Tables 1 and 2, and include the installation of cofferdams and construction of footings and the installation of pier sin both water bodies.

Temporary impacts created through the construction of footings within cofferdams will result in altering Land Under Water in the Charles River and the Millers River. Additional Land Under Water in the Millers River will be affected by temporary piers under Scheme Z. All of the alternatives will result in the placement of permanent bridge piers in the Charles River; however, a net decrease in fill over existing conditions will result of removing the existing I-93 piers in all schemes except for Scheme Z. In addition, all of the alternatives place bridge and ramp piers in the Millers River and, except for Scheme Z, result in filling the northern portion of the millers River for placement of access ramps to I-93 and the Route 1 Tobin Bridge.

The significance of this resource area for food control prevention of storm damage has been rebutted, therefore the performance standards do not apply. The water carrying capacity and water quality of the Charles and Millers Rivers are not anticipated to be affected by Project implementation. The footings in both waterways will be placed below the mudline. The proposed filling of the Millers River will not affect the carrying capacity of that waterbody as the existing water level will be maintained through the Charles River dam controls and the river will continue to flow into the Charles River at the same rate of flow as it currently does. These structure will not adversely affect flows or velocity. In addition, the so-called "Banana Pier" o the existing I-93 bridge will remain in place to provide the hydronamic flow function that it serves. Construction of the footings and piers and associated excavation activities will occur within cofferdams, which will minimize disturbance to adjacent areas.

Two of the alternatives (Alternative 8.1D Mod 5 and the Reduced River-Tunnel Alternative) result in the installation of tunnels beneath the existing river bottoms of both the Charles and Millers Rivers. construction of the tunnels will require the construction of a casting basin, dismantling and subsequent reconstruction of seawalls, and dredging activities. Alternative 8.1D Mod 5 will require the placement of a tunnel under the southern portion of the Millers River, and the Reduced River-Tunnel Alternative requires the placement of two tunnels across the southern portion of the Millers River ramps (N-S, C-N) and alongside a portion of the eastern Millers River.

1.3.2(d) Bordering Land subject To Flooding

Neither the Charles nor the Millers Rivers alter Bordering Land Subject to Flooding along the Charles River and the Millers River. However, both water bodies provide a very limited flood control and storm damage prevention function. These activities include the construction of cofferdams for footings on land and the placement of piers in both water bodies.

The Performance Standards for BLSF outlined in 10.57(4)⁴ are not applicable as the rivers are not significant for flood storage or storm damage prevention.

Nevertheless, the proposed placement of piers in the Charles River will not restrict flows in a manner which will increase flood storage or velocity. The existing banana pier will remain in the river to retain its hydronamic function in regard to the Charles River dam turbine system.

⁴ 1) Compensatory storage for all flood storage volume lost within BLSF (when in the judgment of the issuing authority said loss will cause an increase or will contribute incrementally to an increase in the horizontal extent and level of flood waters during peak flows, and 2) work within BLSF shall not restrict flows so as to cause an increase in flood storage or velocity.

WATERWAYS

1.0 Chapter 91 WATERWAYS LICENSING PROGRAM

Introduction

The purpose of this section is to provide more detailed information with regard to the compliance of the proposed alternatives for the Charles River Crossing with the standards for licensing the project under Chapter 91 of the Massachusetts General Laws and implementing regulations at 310 CMR 9.00.

1.1 Jurisdiction

The Department of Environmental Protection Waterways Regulation program has jurisdiction over filled and flowed tidelands. Flowed tidelands include all water areas which are presently subject to the ebb and flow of the tide. Filled tidelands, which are areas below the historic or natural shoreline, are also subject to jurisdiction, unless they are "landlocked" tidelands. Landlocked tidelands are filled tidelands separated from the water by a public way, provided that the tidelands are at least 250 feet away from the water and are not located within a Designated Port Area.

The Charles River and Millers River areas consists of filled tidelands and flowed waterways. Chapter 91 jurisdiction within the study area is as follows:

Downtown side of the river

In the vicinity of Storrow Drive, Leverett Circle, and the Suffolk County jail, jurisdiction generally extends 250 feet from the water's edge. At the jail the jurisdiction line changes direction and extends further inland (following the former layout of Nashua Street), passing immediately in front of and parallel to the Registry of Motor Vehicles building. The line continues along Nashua Street and the existing I-93/Storrow Drive connector ramps until it nears the I-93 mainline. Here the line changes direction and runs roughly parallel to the I-93 mainline, maintaining a 250-foot distance from the water. Downstream of the I-93 mainline, the line runs along Causeway Street.

Cambridge/Charlestown side of the river

Between the old dam and the Millers River, jurisdiction extends to the Gilmore Bridge and the existing I-93 mainline. Between the Millers River and the new dam, jurisdiction generally extends 250 feet from the edges of the Millers and Charles Rivers.

A general delineation of the Chapter 91 jurisdictional boundaries may be found on Figure 4.43.

1.2 Finding of Water Dependency

A central theme of the Waterways Regulation Program is the promotion of water-dependent uses with separate standards for water-dependent and nonwater-dependent projects. Determination of water-dependency is a necessary prerequisite to assessing compliance with Waterways standards. All of the alternatives include a public infrastructure crossing of the Charles River and all, except for Scheme Z, include a public infrastructure crossing of the Millers River. The Charles River crossing and its on-land and underwater tunnels, ramps, surface roads, utilities and ventilation building(s) are water-dependent public infrastructure crossing facilities for the following reasons:

- 1) All of the crossings meet the definition of a public infrastructure crossing facility defined in the Waterways regulations at 310 CMR 9.12 (2)(b)(9) and (c) as they cannot reasonably be located or operated away from tidal or inland waters.

- 2) In 1990, the Secretary of EOEA made a determination of water-dependency for the Charles River Crossing as outlined in the 1990 DSEIS/R. In the determination, the Secretary noted that the DSEIS/R described several "alternative crossing schemes" for the Charles River which included various combinations of bridges and tunnels and that the determination of water-dependency was "based on the information presented in the DSEIS/R".¹ Since, at the time of the draft EIS/R, more than one alternative for crossing the Charles River was under consideration, the Secretary's determination of water-dependency pertained not to a specific alternative, but rather to the crossing as a functional component of the CA/T Project, regardless of the specific design by which the crossing of the river is achieved. Since the current proposed alternatives represent permutations and hybrids of the alternatives presented in the DSEIS/R, the proposed schemes are also water-dependent.
- 3) All of the project elements² have been placed in their approximate locations for engineering, design and environmental reasons, and therefore, they cannot reasonably be located outside of tidelands. Also, ramp alignments must satisfy specific design criteria which stipulate curve radii, tangent length, weave distance, minimum sight lines and other geometric requirements which significantly limit the ability to realign or relocate ramps and approaches outside tidelands in this vicinity.

Regardless of the specific alternative, the proposed bridges over and tunnel under the Charles River and their on-land tunnels, ramps, boat sections and ventilation building(s) are water-dependent public infrastructure crossing facilities which cannot be reasonably located away from inland or tidal waters. The various structures have been sited in response to agency and public desires to minimize visual impacts, and reduce impacts to wetlands, reduce air pollution and other adverse environmental impacts.

The Secretary's determination of water-dependency for the Charles River Crossing facility (SDEIR Certificate (EOEA #4325) issued 8/29/90) implicitly includes all aspects of the current schemes: "The proposed project includes three such facilities³, across the Boston Harbor, the Charles River and the Fort Point Channel. In accordance with the standards set forth in 310 CMR 9.12 and based on the information presented in the DSEIS/R and the 1985 FEIS/R, I have determined that these infrastructure crossing facilities and their ancillary facilities cannot reasonably be located or operated away from tidal or inland waters."

1.3 Existing Conditions

Jurisdictional waterways resources (filled and flowed tidelands) within the Project area were evaluated to establish their current functional value under the Chapter 91 regulations. The interests of navigation, public access-waterside (flowed tidelands) and landside (filled tidelands), public/social benefit, and the water-dependent uses were evaluated and are described in the following paragraphs.

The filled tidelands around the Charles River Basin include both Commonwealth and private tidelands. Commonwealth tidelands, defined in 310 CMR 9.02, are those areas that lie seaward of either 1) the historic low water line or 2) the 100 rod line⁴, whichever line is closer to land, and that are either held by the Commonwealth or held by a private person by license or grant subject to an express or implied condition that it be used for a public purpose⁵. In addition, Commonwealth tidelands also include private tidelands in public ownership.

CANA Project

In 1987, the MDPW received a Chapter 91 license to construct the CANA Project which included loop ramps in the vicinity of the Charles and Millers Rivers. The Chapter 91 license issued for the CANA

project required landscaping and pedestrian improvements to the infields of the CANA loop ramps, the banks of the Millers River and the north bank of the Charles River, the construction of a pedestrian bridge over the railroad tracks, and a walkway to Rutherford Avenue. To date, approximately 50% of the CANA project subject to the 1987 Chapter 91 license and its requisite mitigation have been constructed. The balance of the CANA project will be re-designed as part of the CA/T project. In addition, under all alternatives except Scheme Z, the existing C-L and C-T stub ramps adjacent to the Charles River will be removed, further reducing the CANA impacts. Hence, some portions of the original CANA project will never be implemented and no additional mitigation for CANA impacts is required (see section 1.5.1 below). CANA will be integrated into the Charles River Crossing and appropriate mitigation will be provided (see Section 1.5 as described in the following).

A description of the interests of Chapter 91 as they presently function in and around each waterbody is provided below.

Charles River

Presently, the Charles River functions well for the Waterways interest of navigation. However, the area presently has no public waterside access and limited or no landside access along the waterfront. The area does provide limited public benefit (i.e flood control). The MDC Gridley Locks and Dam, existing I-93 bridge, the MBTA railroad bridge, the Spaulding Rehabilitation Hospital pier and the MDC Harbor Police are the only water dependent uses within this section of the river.

Millers River

The Millers River presently has a low functional value for all waterways interests.

All functions are rated low as the river is non-navigable, has no waterside public access, has limited landside public access, provides minimal public benefit, and contains no water-dependent uses.

Navigation

Charles River

The Lower Charles River Basin does not have a defined channel. The upstream limit of the Army Corps of Engineer's federal navigation project for the Charles River is the North Washington Street Bridge. Historic State Harbor lines exist in the area, but have little relation to current navigation, due to the filling and bridge and dam construction which has occurred over the years.

The lower Charles River is officially navigable and has several marinas and boat clubs on its north shore. However, there are no marinas in the Lower Charles River between the two dams. A system of two dams separates the river from Boston Harbor. The inner, or old Charles River dam, is located by the Museum of Science at the head of the Charles River Basin. It has one lock which is maintained in an open position and leads into the Lower Charles River. The outer, or new Charles River dam, is located immediately east of the existing Central Artery high bridge. There are three locks located in the new dam, and all vessels navigating between the basin and Boston Harbor must pass through these locks. The largest lock can accommodate vessels up to 300 feet long with a 40 foot beam. The controlling depth in the area between the two locks is 15 feet. Directly below the new Charles River dam, where the mouth of the Charles River meets the Inner Harbor, is a navigable waterway area with a depth ranging from 20 to 35 feet. It is used primarily for recreational boating.

At present, there is relatively little commercial traffic navigating the Charles River. Commercial activity is limited to barges which are used for either fireworks displays or construction activities. The largest

barges currently operating in the Charles are approximately 145 by 32 feet, and total barge lockings are estimated at 60 per year, or an average of one every 6 days.

Millers River

The Millers River is a short (approximately 1,000 feet in length) and shallow waterway (3 feet in depth) on the north side of the Charles River located just above the new Charles River Dam. The present Millers River is the only visible remnant of a stream whose headwaters once were in Somerville. It is hydraulically connected to the Charles River by two 84-inch culverts which run through an eastern berm about 80 feet across at the surface. Drainage into the open portion of the waterway at its upstream terminus is through three 48-inch storm drains servicing a densely developed urban and industrial area. Additionally, a 54" and 72" storm drain carry water from existing I-93 to the head of the Millers River.

Public Access-Waterside and Landside

Charles River

The waterway between the two dams is not used for water-based recreational activities, but rather, as a transportation passageway for vessels navigating between the Charles River Basin and the Harbor. Water-based recreational activities generally occur either in the Charles River Basin or in the Harbor, and not in the Lower Charles. Currently, the waterway provides a focus for landside viewing at the Paul Revere Landing Park and at the recreational pier behind Spaulding Rehabilitation Hospital.

Current land uses at the water's edge are primarily rail transportation, industrial, institutional (hospital and jail), and open space uses. There are two active water-dependent uses, the MDC Gridley Dam and Locks and the MDC Harbor Police. In addition, there is approximately 7,700 l.f. of waterfront along the Charles River. Of this, approximately 2,500 l.f. consists of existing sidewalks or walkways which are open to the public. These areas include a sidewalk along the O'Brien Highway, and walkways along the north side of the River at the Paul Revere Landing North Park, on the south side along the Spaulding Rehabilitation Hospital (SRH) west of the bascule bridge and in front of the MBTA parking lot east of the bascule bridge. There are also structures which cross the river and which contain public and private access. The MBTA bascule bridge contains approximately 640 linear feet of walkways open to the public. This public access is limited to the southern portion of the bridge and is on both the east and west side. The MDC dam also crosses the river and has 1,200 l.f. of structure along the river (including both sides). Of this, 600 l.f. contain a walkway on the west side of the dam and are open to the public. There is also access from Causeway Street north to the river, east of the Boston Garden complex.

Finally, implementation of the 1993 CANA Temporary Loop Ramps permits⁶ will result in improvements to the Paul Revere Landing North Park and will create a walkway connection from Rutherford Avenue and City Square to the Charles River via Paul Revere Landing North Park. Said improvements will provide an enhanced park and public access along the Charles River.

There are no commercial water transportation facilities in the lower Charles River Basin or in the mouth of the river south of the new Charles River dam. Boats queue by the Charlestown bridge while waiting to travel into the basin and below the North Station bascule bridge when travelling to the Harbor. Due to calm water conditions, boats generally do not drop anchor while waiting to pass through the locks, even in bad weather.

Millers River

There is no existing water-based public access on the Millers River (and no physical opportunity to create any) and limited landside public access. There is no public access on the north and west sides of the

Millers River and minimal access along the south and east sides in the form of access roads. Of the total 2,200 l.f. of waterfront on the Millers River, none of it functions as public access.

Water-dependent Use and Public/Social Benefit

Charles River

The North Point area of Cambridge is located on the north side of the Charles River, west of the Millers River and includes primarily the nonwater-dependent uses of an MDC maintenance facility, an MHD storage area, railroad tracks and piggyback yards owned by Guilford Transportation Industries, and a solid waste transfer station. The MWRA Prison Point Pumping Station is also located in this area. The riverfront property in this area is both publicly and privately owned.

Paul Revere Landing North Park is located on the north side of the Charles River dam. An access road (constructed under the CANA project) runs from the North Washington Street Bridge to Tower A. This road runs between the Charles and Millers River and crosses the Paul Revere Landing Park.

On the south side of the River, land uses are predominantly public institutional and include the Spaulding Rehabilitation Hospital, the Suffolk County jail, North Station, the Boston Garden, and various highway ramps and parking lots.

There are currently no active uses of the water's edge for boat landings or marinas above the Gridley Dam and Locks within the project area. The only active water-dependent use below the Charles River dam is the MDC Harbor Patrol dock. Outside of the project area, the first active uses of the shoreline for boating upriver are the Community Boating facility in Boston, the excursion boat landing at the Science Museum, and the Charlesbank Marina on the Cambridge side, all of which are outside of the project limits. Below the North Washington Street bridge, the north side of the Harbor contains the Constitution Marina and on the south side, the water's edge is reserved for public access as part of the Harborpark walkway system.

Millers River

The area adjacent to the Millers River contains highway viaducts, ramps, local roadways and the MBTA rail yards. The Boston Sand and Gravel Company presently operates its facility out of property adjacent to the westerly and northerly banks of the Millers River. The area east of the Millers River, extending to Rutherford Avenue consists primarily of surface roadways, highway infields, the I-93 viaduct structure, and viaducts as well as the tunnel portal of the CANA project. An access road for Boston Sand and Gravel runs along the eastern side of the Millers River and an access road runs from the North Washington Street Bridge to Tower A parallel to the Charles River.

1.4 Impacts and Conformance with Performance Standards

Because the project is a public infrastructure crossing project undertaken by the Massachusetts Highway Department, a state agency, it is presumed to serve a proper public purpose which provides greater benefit than detriment to the rights of the public in said lands. In addition, the Special Procedures for licensing the CA/T project adopted by DEP on May 16, 1991, state that, "...the CA/T project has been determined to merit special consideration for expedited review because there is a significant public benefit associated with the project".

The entire project is water-dependent public infrastructure crossing facility. The project must meet the performance standards outlined in 310 CMR 9.31 through 9.40.

Temporary Impacts

Temporary affects to navigation and existing, substandard public access will occur during construction. Construction related activities in flowed waterways include installation of cofferdams and piers and removal of existing piers, bridges, and structures such as fenders. In filled tidelands, construction activities include construction of ventilation buildings, surface roads, ramps, cut and cover tunnels, relocation and installation of utilities, and underpinning of various structures. In addition, those alternatives which include in-water tunnels will require dredging and dredge material disposal, installation of tunnels, construction of a casting basin, and dismantling and reconstruction of existing seawalls.

Permanent Impacts

Permanent project activities in flowed tidelands include bridge piers in the Charles River, bridge and ramp piers in the Millers River, and the placement of approximately 1.1 acre of fill in the Millers River. All alternatives include a new I-93 mainline bridge. In all cases except for Scheme Z's Storrow Drive bridge, the bridges will be single-deck structures. The proposed I-93 mainline bridge has been designed to accommodate a long span, cable-stayed structure and the number of piers has been reduced from the 17 proposed in the 1990 DSEIS/R. Such improvements substantially reduce the navigational impacts and improve pedestrian shoreline views along existing waterfront walkways and parklands. Under Scheme Z and Non-River-Tunnel Alternative, a second bridge over the Charles River for Storrow Drive traffic will require the placement of piers in and along the banks of both water bodies. The number and location of bridge piers varies according to the particular bridge design. In the Millers River, the number of mainline piers varies according to the specific alternative and, approximately one acre of fill is proposed for all alternatives except for Scheme Z to accommodate access ramps which meets the definition of a water-dependent public infrastructure facility. In filled tidelands, permanent impacts include tunnels, surface roads, viaducts, bridges and ventilation building(s). Permanent impacts are shown in Table 3.

1.4.1 Impacts by Alternative

The project will have both positive and adverse impacts on land use, open space, and visual conditions, which vary depending on the particular location within the project. Some of the impacts are common to all of the alternatives analyzed, and some are unique to the specific alternative.

Scheme Z and the three new design alternatives may have a minor affect on the MDC Gridley Dam and Lock operators' view corridor and this will be evaluated in more detail in subsequent bridge design review.

All alternatives except for Scheme Z, remove the existing CANA ramps C-L and C-T stubs along the north bank of the Charles River, and relocate these ramps in tunnels or ramps further away from the shoreline, thereby further improving views, public access and open space opportunities. The reduced number of piers in the water and along the shore coupled with the removal of the existing I-93 piers and a more aesthetically pleasing bridge design, will improve pedestrian shoreline views to and along the existing waterfront walkways and parklands.

Existing visual obstructions adjacent to the Paul Revere Landing Park North and the MDC dam walkway will be alleviated through the removal of the existing I-93 superstructure, CANA stub ramps C-L and C-T and bridge piers. The pier removal will also increase the areal extent and volume of the flowed portion of the Charles River. Finally, all alternatives except for Scheme Z require the construction of ventilation buildings on filled tidelands. In all cases, these facilities will be placed where existing nonwater-dependent uses are presently located. The visual effect of these ventilation buildings on existing open space and parklands are described for each alternative in Section 4.2.2 of this DSEIS/R. Three of

Table 3
STATE WATERWAYS PERMANENT IMPACTS
(acres)

Alternative	Activities	Flowed Tidelands ^a	Filled Tidelands ^a
Millers River			
Scheme Z	Highway structures ^b	1.6 ^c	12.8
	Retaining wall	0.00	0.04
	Total	1.1	12.8
8.1D Mod 5	Highway structures	1.7 ^d	12.4
	Total	1.7	12.4
Reduced River-Tunnel	Ventilation building	0.00	0.2
	Highway structures	1.6 ^e	14.2
	Total	1.1	13.1
Non-River-Tunnel	Highway structures	1.6 ^e	14.2
	Total	1.8	14.2
Charles River			
Scheme Z	Highway structures	2.6	5.5
	Piers (in water)	0.10	0.00
	Total	2.7	5.5
8.1D Mod 5	Highway structures	3.1	10.1
	Piers (in water)	0.009	0.00
	Total	3.1	10.6
Reduced River-Tunnel	Highway structures	3.2	13.1
	Piers (in water)	0.012	0.00
	Total	3.2	10.6
Non-River-Tunnel	Highway structures	2.8	13.1
	Piers (in water)	0.014	0.0 ^g
	Total	2.6	13.3

^a Includes structures on or above tidelands, such as tunnels or bridges.
^b Highway structures include footprint of tunnels, surface roads, ramps, and viaducts.
^c Includes 0.0 acre piers.
^d Includes 1 acre of fill and 0.013 acre of piers.
^e Includes 1 acre of fill and 0.015 acre of piers.
^f Includes 1 acre of fill and 0.014 acre of piers.
^g Below grade.

the alternatives, 8.1D Mod 5, Reduced River-Tunnel Alternative and Non-River-Tunnel Alternative also require ventilation building(s) to be constructed on filled tidelands.

Impacts to flowed and filled tidelands by individual alternative are outlined below.

All Alternatives

Temporary

- Demolition of the existing I-93 bridge (Removal of all but one pier in the Charles River)
- Demolition of CANA Temporary Loop Ramps
- Installation of I-93 mainline pier footings (Charles and Millers Rivers)

Permanent

- Approximately 1.1 acre of fill in Millers River for access ramps north of Charles River (except Scheme Z; ramps T-N and N-T)
- I-93 Mainline bridges and ramps including footings & piers (filled and flowed)
- Surface roads south of Charles River (portions of mainline; Storrow Drive; Nashua Street; Leverett Circle Interchange; O'Brien Highway and very small portions of ramp N-L and Charles Street)
- Boat sections south of Charles River (portions of mainline; ramps L-CS; CN-S; SA-CN)
- Viaducts north of Charles River (portions of mainline; ramps T-C; N-S; T-S; C-L)
- Viaducts south of Charles River (portions of mainline and ramp N-S)
- Land Tunnels on the south side of Charles River (portions of the mainline portions of ramp L-CS; CN-S)

Alternative 8.1D Mod 5

This alternative involves a mainline I-93 bridge with a three lane tunnel under the Charles River to provide the Storrow Drive connector/Route 1 bridge and I-93 connections.

Temporary impacts will occur as a result of the tunnel construction. This activity will require dredging of 95,000 c.y. of material of a 57,000 s.f. area in the Charles River; construction of a graving basin and dismantling and reconstructing 660 l.f. of existing seawalls. A portion of the river tunnel ramps S-N and C-T will be placed in the southern portion of the Millers River.

Construction of the new I-93 Bridge over the Charles River requires one pier in the River. However, the existing I-93 piers will be removed from the River resulting in a net increase in water sheet and volumes. In addition, there will be two ramps (L-C and T-C) in a cloverleaf structure east of and above the Millers River. This alternative requires an above ground ventilation building on about 0.5 acres at the site of the Spaulding Rehabilitation Hospital (to be relocated).

Temporary

- Dredging
- Tunnel placement
- Cut-and-cover tunnels (north and south sides of the Charles River and alongside Millers River)
- Casting basin
- Seawall dismantling and reconstruction (tunnel approaches and casting basin)

Permanent

- 1 pier in Charles River and 2.5 piers in Millers River from the I-93 Mainline Bridge
- 1 Pier on the north bank within 100 feet of Charles River from loop ramps.(Mainline bridge pier)
- Boat Sections north of Charles River (portions of ramps S-N; very small portion of C-T)
- Boat Sections south of Charles River (portions of ramp ramps L-CS)
- Viaducts south of Charles River
- On land tunnels north side of Charles River (portions of ramps S-N; C-T)
- On land tunnels south side of Charles River (portions of ramps L-N; M-N; C-T; ST/CN-S)
- In water tunnels, Charles River (portions of ramps S-N; C-T in Millers and Charles)
- One Ventilation Building (#8) south side of Charles River at the site of the Spaulding Rehabilitation Hospital

Reduced River-Tunnel Alternative

This alternative requires the construction of a mainline I-93 bridge and a tunnel (S-N) to provide the Storrow Drive North connector/Route 1 bridge across the Charles River and a tunnel to provide north to south. The tunnel and bridges will be placed upstream of the existing Charles River bridge.

Construction of the tunnel will require dredging of 60,000 c.y. of material of a 36,000 s.f. area from the Charles River; construction of a casting basin and dismantling and reconstruction of existing seawalls.

The bridges will require placement of 1.5 piers in the Charles River and four piers in the Millers River. In addition, there will be 3 ramps (L-C, T-C and C-T) in a cloverleaf structure east of and above the Millers River. The tunnels crossing the southern half of the Millers River will be placed entirely underneath the existing bottom.

Two ventilation buildings - a below grade 0.2 acre footprint structure on the south side of the River between Nashua Street and the MBTA tracks and an above grade structure on 0.2 acres on the north side of the River on the south west side of the Millers River will be required.

Temporary

- Dredging
- Tunnel placement
- Cut-and-cover tunnels (north and south sides of the Charles River and alongside the Millers River)
- Casting Basin
- Seawall dismantling and reconstruction (tunnel approaches and casting basin)

Permanent

- 1.5 piers in Charles River and 4 piers in Millers River from I-93 mainline bridge
- On south side, 4 piers within 100 and on north bank 2.5 piers within 100 feet of Charles River form I-93 Mainline Bridge.
- Surface roads north of Charles River (portions of ramps N-S; N-T; T-N; S-N)
- Surface roads south of Charles River (portions of ramps SA-CN)
- Boat sections north of Charles River (portions of ramp S-T; S-N)
- Viaducts north of Charles River (portions of C-T; SA-CN)
- Viaducts south of Charles River

- On land tunnels north side of Charles River (portions of ramps S-N & S-T)
- On land tunnels south side of Charles River (portions of ramps M-N; S-N)
- In water tunnels (portions of S-N and S-T in Charles and Millers Rivers)
- Two smaller ventilation buildings (#'s 8 and 9) one on south side in Boston Garden and on north side on West side of Millers River on Boston Sand and Gravel property)

Non-River-Tunnel Alternative

This alternative involves two bridge crossings of the Charles River: I-93 mainline and Storrow Drive connector/Route 1 bridges (N-S & S-N).

All the bridges will require the placement of piers in and adjacent to the Charles River. The I-93 mainline and Storrow Drive/North bridges will require the placement of piers in Millers River. There are four ramps (S-T, T-C, C-T, L-C) contained in a cloverleaf structure east of and above the Millers River. These ramps will require 3.5 new piers in the Millers River. This alternative also requires a below grade 0.2 acre structure on the south side of the Charles River between the Registry building and Nashua Street.

Temporary

- Dredging
- Cut-and-cover tunnels (south side of the Charles River)
- Seawall dismantling and reconstruction

Permanent

- 5.5 piers in Charles River and 3.5 piers in Millers River from I-93 mainline bridge
- 4 piers in Charles River and 2 piers in Millers River from S-N/N-S bridge
- 2 piers within 100 feet on south bank and 1 pier within 100 feet on north bank of Charles River from I-93 Mainline Bridge.
- 2 piers on south bank and 2 piers on north bank within 100 feet of Charles River from Second Bridge.
- Placement of 4 loop ramps (S-T; T-C; C-T and L-C) in viaduct on north side of Charles River
- Surface road north of Charles River (turnaround from Charles Street south to Storrow north)
- Boat sections north side of Charles River
- Viaducts north of Charles River (portion of ramps C-T; SA-CN;S-N)
- Viaducts south of Charles River (portion of ramp S-N)
- On land tunnels south side of Charles River (S-N)
- A below grade ventilation building between the Registry Building and Nashua Street

1.4.2 Conformance with Performance Standards

Because the project is a water-dependent public infrastructure crossing project undertaken by the Massachusetts Highway Department, a state agency, it is presumed to serve a proper public purpose which provides greater benefit than detriment to the rights of the public in said lands.

Water-dependent projects must address the public interests of fishing, fowling, navigation and public access.

The major components of the Alternatives are reviewed below to demonstrate compliance with the applicable standards found in Part III of the Waterways Regulations. Certain Part III standards are not applicable due to the nature of the project and other Part III standards are treated generically below.

1.4.2.1 Categorical Restrictions on Fill and Structures

Scheme Z and the three new design alternatives require the placement of bridge piers in the Charles River and bridge and ramp piers in the Millers Rivers. As pier supported structures for water dependent uses, the proposed bridges comply with the categorical restrictions outlined in 310 CMR 9.32 (1)(a)(2).

Legislation addressing project compliance with existing Harbor Lines will be pursued.

1.4.2.2 Environmental Protection Standards

All Alternatives

Scheme Z and the three new design alternatives comply with the approved Massachusetts Coastal Zone Management (MCZM) Program and will be conducted in a manner consistent with that program. A statement regarding the consistency of the project is included in Appendix E. Prior to the issuance of an individual license for the activities described herein, the project will comply with the provisions of the Massachusetts Environmental Policy Act; obtain required approvals under the Wetlands Protection Act; and obtain a Water Quality Certification for activities as required in this area.

1.4.2.3 Conformance with Municipal Zoning and Harbor Plans

The Cambridge Zoning Laws and the Boston Zoning Code are not applicable to the Project, a state highway project. The City of Cambridge does not have an approved Municipal Harbor Plan. The Secretary of Environmental Affairs approved the City of Boston Municipal Harbor Plan on May 22, 1991. The Plan covers Boston Harbor proper and thus, the project area is outside the plan boundaries. In the approval, the Secretary found that the Municipal Harbor Plan does not apply "to any state project or portion thereof that is exempt from zoning requirements by law". The CA/T, as a state public works project, is exempt from compliance with local zoning by-laws and therefore, the approved municipal harbor plan does not apply to this project.

1.4.2.4 Standards to Preserve Water Related Public Rights

All Alternatives

While project impacts will occur in both filled and flowed tidelands neither Scheme Z nor the three new design alternatives significantly impair the rights held by the Commonwealth in trust for the public to use tidelands for public purposes which include water related rights and interests in fishing, fowling, navigation, and public access.

Public Rights Applicable to All Waterways

Navigation

Under Scheme Z and the three new design alternatives, there will be temporary impacts on navigation due to construction activities, but the permanent impacts of the Project on navigation are expected to be minimal. No piers will be placed in the "navigation channel." The proposed bridges will have a minimum vertical clearance of 23 feet above recreation locks and 30 feet above the commercial lock, which will ensure maintenance of existing minimum clearances in the river. Shading impacts on the

boaters is expected to be a minor factor in navigation, as vessels in this area generally are moving at a slow speed or queuing to wait for the bascule bridge or the locks to open.

Scheme Z and the three new design alternatives place permanent piers in the river, outside the navigation channel. These impacts will be offset through the removal of existing I-93 bridge piers and, unlike Scheme Z, the three new design alternatives result in a net increase in the resource areas (flowed tidelands) of the Charles River. Hence, no significant interference with public rights of navigation⁷ will occur. Bridge and ramp piers as well as fill will be placed in the Millers River. However, the Millers River is non-navigable; therefore, these activities will not adversely affect the navigational interests in these areas (see Section 4.5.3, Navigation).

Pier A, the "reverse" banana pier, will remain in the water to maintain the existing uniform flow approach to the pump station downstream. This remaining pier will be clearly marked so that it will not be a navigational hazard. Under Alternative 8.1d Mod 5 and the Reduced-River-Tunnel Alternative additional temporary navigation impacts will also result from activities associated with tunnel construction. Bridge and ramp piers, as well as one acre of fill, will be placed in the Millers River. However, the Millers River is non-navigable and these activities will not adversely affect the navigational interests in this area.

While all alternatives place new piers in the Charles River, they will have been reduced in number from 17 in the 1990 DSEIS/R and have been sited outside the main lines of navigation to minimize impact on vessel traffic. In addition, fendering systems will be installed in piers. Although the lower Charles River Basin is constrained by the Gridley Locks, the B&M Railroad bridge, Green line overpass, and the old Charles River Dam bridge and lock, it is heavily used during the summer months for recreational boating. A 300 foot barge with two tugs will still be able to transit the waterway.

No permanent adverse impacts to navigation will result from the proposed project.

Charles River

Alternative 8.1D Mod 5

The placement of tunnels under the Charles River will temporarily affect navigation, however the tunnels will cause no permanent impact.

The placement piers in the water will temporarily affect navigation during construction. The piers will be placed outside of the "navigation channel" and thus there will be no adverse permanent impacts to navigation caused by this bridge pier.

Reduced River-Tunnel Alternative

The placement of tunnels under the Charles River will temporarily affect navigation, however the tunnels will cause no permanent impact. The placement of 1.5 piers in the water will temporarily affect navigation during construction. All piers will be placed outside of the "navigation channel" and thus there will be no adverse permanent impacts to navigation caused by the bridge piers.

Non-River-Tunnel Alternative

The placement of piers in the water will temporarily affect navigation during construction. All I-93 mainline bridge piers will be placed outside of the "navigation channel" and thus there will be no adverse permanent impacts to navigation caused by these bridge piers. Permanent impacts will be created from the Storrow Drive/Tobin Bridge piers. However, these piers will be placed outside the existing navigation channel, behind the fendering system.

Millers River

All Alternatives

The Millers River is non navigable and thus, no impacts to navigation will occur.

Free Passage Over and Through Water

None of the alternatives will preclude free passage over and through the Charles River. Passage over and through the Millers River is presently precluded.

Access to Town Landings

There are no town landings within the project area and thus, this standard does not apply.

Fishing and Fowling

All Alternatives

The project will not significantly interfere with the public rights of fishing and fowling.⁸ Access along the banks of the Charles River, which is currently limited by public safety constraints due to the presence of highways, railroad tracks and other institutional uses, will be vastly improved. Continuous public access will be provided along the north bank from North Point along the river, thence over a pedestrian bridge along the railroad tracks, and continuing along the bank to Paul Revere Landing Park. On the south side, access will be provided from North Washington Street bridge to the Gridley Locks to the current walkway along the north bank past the railroad tracks. Pedestrian access will be provided along both edges of the railroad draw, allowing pedestrians to cross the Charles in both directions and allowing continuous access along the north and south bank.

The performance standards are met as the project will not pose any substantial obstacle to the public's ability to fish or fowl in the waterway areas adjacent to the project site; and the project will not result in the elimination of traditional fishing or fowling locations used extensively by the public.

On Foot Passage

All Alternatives

The project does not significantly interfere with the public's right to walk or otherwise pass freely on private tidelands for purpose of fishing, fowling , navigation and the natural derivations thereof; and on Commonwealth tidelands and Great Ponds for said purposes and all other lawful activities.⁹

All of the alternatives provide the opportunity to increase substantially the amount of public access on the waterside and landside. Under each alternative except Scheme Z, the existing C-L and C-T ramps stubs will be eliminated along the north bank of the river, greatly reducing the adverse visual and public access impacts of the project on the filled tidelands as compared to those described in the FEIS/R. In addition, the highway viaduct structures connecting the Artery/Tunnel Project to the CANA project on the Charlestown side have been substantially re-designed in tunnel or located further away from the river bank, resulting in a much improved pedestrian and visual quality in the general area. One consequence of these re-designs however, is the need to place some of these movements in a location which requires filling in the Millers River. In all cases, the removal of the existing I-93 bridge will substantially improve the Paul Revere Landing Park and areas adjacent to the Charles River bank on the north side. Disruption to existing pedestrian usage within the entire Chapter 91 jurisdiction is minimal because of the dearth of pedestrian usages now in the area. Consequently, the net effect of any of the schemes currently being considered is one of opening up the area to pedestrian use. Chapter 4.2.2, which details

the open spaces and parklands demonstrates that the proposed improvements outweigh any adverse impacts.

Public access along the banks of the Charles River, which is currently limited by public safety constraints due to the presence of highways, railroad tracks and other institutional uses, will be increased and improved. Along the north bank, access will be provided from and over the Bascule bridge to the Paul Revere Landing North Park. No access is proposed along the Millers River.

The Project will result in a substantial increase in area devoted to water-dependent uses, and the project provides reasonable measures for on-foot passage along and to portions of the north and south bank of the Charles River.

Compensation for interference with Public Rights in Commonwealth Tidelands

The project is not proposing any private use of Commonwealth tidelands and thus compensation does not apply.

Management of Areas Accessible to the Public

The long term management of public facilities (walkways and open space) located on tideland areas accessible to the public shall be identified during the licensing process for this area.

Standards to Protect Water-dependent Uses

The only existing water-dependent uses on the Charles River within the project area are the MDC Gridley Dam and Locks, the MDC Harbor Patrol, Spaulding Rehabilitation Hospital pier and the existing railroad and I-93 bridges. The project preserves the availability and suitability of these waterways as they are presently utilized by the existing water-dependent uses. The Charles River Crossing alternatives will have minimal impact on navigation and will not impede the right of access by water to adjacent property owners' land. All alternatives will result in increasing the amount of water-dependent uses and improving benefits to the public in and along the Charles and Millers Rivers.

Another beneficial impact of the new alternatives is that the MDC Master Plan is presently being finalized and the proposed project will accommodate implementation of portions of the plan. Without the project, the achievement of open space improvements and functional pedestrian linkages would occur in a more incremental fashion, over a longer time horizon, or not at all, constrained by public funding or redevelopment planning by the public and private sectors.

Private Access to Littoral or Riparian Property

None of the bridge piers proposed in the Charles River affect private access to riparian property. In the Millers River, access from the water is not presently available and private access to the water will not be precluded. The project does not interfere with littoral or riparian property owners' right to approach their property from a waterway, and vice versa.

Disruption of Water-dependent use

The only effect the project may have on an existing water-dependent use is a minor affect on the MDC Gridley Dam and Lock operators' view corridor. While views within the "navigation channel" will not be affected by any alternative except Scheme Z, all alternatives will obstruct views in areas outside of the "navigation channel." This obstruction will result from the design of the proposed mainline bridge which will be approximately 25 feet lower than the existing I-93 bridge on the north side and 10 feet

lower on the south side. However, the existing I-93 bridge and its associated piers will be removed, which will increase the overall visibility on the river for boaters and dam operators.

Displacement of water-dependent uses

There are no existing water dependent uses in the project area that will be displaced by the project except for the I-93 bridge which will be removed and replaced by a new bridge. The nearest water dependent uses are the Gridley Dam and Locks and MDC Harbor Patrol.

Fill or structures which preempt water-dependent industrial use within a Designated Port Area

The project area is not a Designated Port and thus this standards does not apply.

1.4.2.5 Engineering and Construction Standards

The project is being designed and will be constructed in accordance with accepted Engineering and Construction Standards.

1.4.2.6 Use Standards for Recreational Boating Facilities

No recreational boating facilities are being affected being proposed therefore this standard does not apply.

1.4.2.7 Standards for Marinas, Boatyards and Boat Ramps

No marinas, boatyards or boat ramps are being proposed, thus this standard does not apply.

1.4.2.8 Standards for Dredging and Dredged Material Disposal

Alternative 8.1D Mod 5 and the Reduced River-Tunnel Alternative require dredging activities to install underwater tunnels. In addition, limited additional dredging will occur in connection with the placement of bridge piers. These dredging impacts are temporary, (See 4.13) and will meet the waterways standards.

Dredge material will be disposed of in accordance with the analysis in Section 5.2, Materials Disposal.

1.5 Proposed Mitigation Measures

Permanent impacts will unavoidably alter or remove some existing Waterways resources, including filled and flowed tidelands.

Mitigation is designed to offset aspects of the project which create permanent adverse affects to the existing interests of navigation, water-dependent uses, fishing, fowling and on-foot passage. Mitigation for these activities will include improvements to navigation. In addition, improvements to pedestrian passage to and along the Charles River is proposed. The Project, in conjunction with other aspects of the overall CA/T Project also will improve highway access to the maritime industrial Port of Boston and in most cases, improves the Waterways functions within the Project alignment.

Summary Of Project Impacts. Scheme Z and the three new design alternatives minimally alter or remove some existing waterway resources, including filled and flowed tidelands. However, MHD will provide mitigation for impacts and, compared to existing conditions, will improve the waterways functions within the Project alignment. The Charles River crossing, in conjunction with other aspects

of the overall Project, will substantially improve highway access to the maritime industrial Port of Boston.

The analysis of impacts and conformance with performance standards demonstrates that the Project has no adverse long-term effect on the interests of fishing and fowling and thus, no mitigation for these interests is required. Under all alternatives, on-foot passage within the Project area is greatly enhanced over existing conditions, and public access improvements will be made.

All Project activities within Chapter 91 jurisdiction, regardless of alternative, are water dependent. A large portion of these facilities are underground structures which will have minimal impact on the public interest in filled tidelands.

CANA Mitigation. The 1991 FSEIS/R includes specific mitigation measures designed to offset the improvements required under separate but related CANA projects. The CANA project has been partially completed under the CANA Chapter 91 license, issued in 1987. The balance of the project has been redesigned and will be integrated into the Central Artery/Tunnel project. Portions of the existing CANA project will be removed under the three design alternatives. The CANA project as originally licensed will not be constructed, and the original CANA mitigation measures are no longer applicable. Appropriate waterways mitigation will be provided as part of the Revised Charles River crossing project, as described below.

Revised Charles River Crossing Mitigation. Mitigation is limited only to those impacts which adversely affect the public interests in the preservation of water-related public rights in tidelands including navigation, fishing and fowling, and the provision of on-foot passage where possible. Impacts are limited to navigation related interests and mitigation measures include the provision of fendering systems and maintaining the view corridor of the MDC dam and locks operators. The regulations also require the provision of on-foot passage along or to the shoreline within or from the Project site. Substantial on-foot passage will be provided by the Project along the north and south sides of the Charles River, which is equivalent to the total linear footage of shoreline occupied by Project structures.

Scheme Z and the three new design alternatives will result in extensive mitigation along the Charles River. On the north bank of the Charles River, a total of approximately 1,000 lf of public access will be provided extending west of the Paul Revere Landing Park North, including a pedestrian bridge over the railroad tracks. In addition, a 1,200 lf walkway will be provided from Rutherford Avenue to the Charles River via the land west of the Millers River.

Public access will be provided on the south side of the Charles River, approximately 500 lf along Lovejoy Wharf and 400 lf from Causeway Street to Lovejoy Wharf.

FOOTNOTES

1. From the Mitigation Summary of the *Secretary's Certificate*, section 5.
2. As used herein, the word "project" refers to the Charles River Crossing portion of the Central Artery/Tunnel Project, unless indicated otherwise. Infrastructure crossing facilities as defined under 310 CMR 9.12.
3. A line 100 rods (1,650 feet) seaward of the historic high water line.
4. Such lands may be found not to be Commonwealth tidelands only if there is a final judiciary decree or other conclusive legal evidence establishing that these tidelands are unconditionally free of any proprietary interest in the Commonwealth.

5. Such lands may be found to be Commonwealth tidelands only upon a showing that these tidelands are not owned by a private person.
6. In 1987, the MDPW (now MHD) received a Chapter 91 license to construct the CANA Loop project in the vicinity of the Charles and Millers Rivers which required certain mitigation. Subsequently, the CANA project was never completed and portions are being redesigned. In addition, in 1993 the Department secured authorizations to construct temporary CANA loop ramps with certain conditions to be implemented within the following 18 months. The mitigation measures which will be implemented within the next two years are assumed to be in place for the functional analysis of existing conditions.
7. Such interests include the protection of maritime commerce, industry, recreation, and associated public access; the protection, restoration, and enhancement of living marine resources; the attainment of water quality goals; the reduction of flood and erosion-related hazards on lands subject to the 100 year storm event or to sea level rise, especially those in damage-prone or natural buffer areas; the protection and enhancement of public views and visual quality in the natural and built environment of the shoreline; the preservation of historic sites and districts, archaeological sites, and other significant cultural resources near waterways.
8. The proposed bridges will be approximately 25 feet lower than the existing I-93 bridge on the south side and 10 feet higher on the north side than the existing I-93 bridge, and it will have a deeper road section.
9. Including the right to conduct any activity involving the transport or the loading/unloading of persons or objects to or from any such watercraft; and the natural derivatives thereof.
10. Includes the right to seek or take any fish, shellfish, fowl or floating marine plants by any legal means, from a vessel or on foot; the right to protect habitat and nutrient source areas.
11. Includes swimming, strolling, and other recreational activities.
12. This includes the assumption that the mitigation required in the 1993 Chapter 91 license for CANA temporary loop ramps are in place.

Appendix E: Coastal Zone Management Consistency Statement

Appendix E

COASTAL ZONE MANAGEMENT CONSISTENCY STATEMENT

STATE COASTAL ZONE MANAGEMENT PROGRAM

The Massachusetts Coastal Zone Management (MCZM) Program was established to protect and manage the development and use of the coastal zone under the provisions of the Federal Coastal Zone Management Act of 1972. This is accomplished by reviewing proposed developments in the zone in terms of consistency with 27 regulatory and nonregulatory MCZM policies.

In the Area North of Causeway Street project subarea, the existing I-93/Route 1 bridge forms the western boundary of the Coastal zone. However, since Project activities and structures upstream of the I-93 bridge are an integral part of the Charles River crossing and have the potential to impact the coastal zone, Scheme Z and the three new design alternatives are evaluated in their entirety for consistency with CZM policies.

On December 1, 1983, CZM granted conceptual concurrence that the FEIS/R Preferred Alternative for the Central Artery/Tunnel Project which was approved in 1985, complies with CZM Program policies. This was reconfirmed for Scheme Z which was approved in 1991. The CZM office will also review Federal actions, such as the issuance of USACE Section 10 and 404 permits, for consistency after this DSEIS/R and the FSEIS/R for the preferred alternative are approved. The following discussion details the manner in which consistency with CZM policies will be achieved by any of the four designs in the Area North of Causeway Street.

These following regulatory and nonregulatory policies are quoted from the CZM regulations and are followed by a statement of applicability or consistency.

1 REGULATORY POLICIES

Policy R1

"Protect ecologically significant resource areas (saltmarshes, shellfish beds, dunes, beaches, barrier beaches, and salt ponds) for their contributions to marine productivity and value as natural habitats and storm buffers."

None of the habitats designated by Policy R1 occurs in the area of the four designs. Consequently, Policy R1 does not apply to the Project.

Policy R2

"Protect complexes of marine resource areas of unique productivity [Areas for Preservation or Restoration (APRs)/Areas of Critical Environmental Concern (ACECs)]; ensure that activities in or impacting such complexes are designed and carried out to minimize adverse effects on marine productivity, habitat values, water quality, and storm buffering of the entire complex."

No areas which have been designated as APRs or ACECs are located within Project limits. Thus, Policy R2 does not apply to the Project.

Policy R3

"Support attainment of the national water quality goals for all waters of the coastal zone through coordination with existing water quality planning and management agencies. Ensure that all activities endorsed by CZM in its policies are consistent with Federal and State effluent limitations and water quality standards."

A water quality monitoring program will be implemented during construction in accordance with the Project NPDES permit # MA-0033928 issued September 30, 1991, and amended July 15, 1992, and March 31, 1993.

All of the designs except for Scheme Z involve land-based tunnels. Alternatives 8.1D Mod 5 and the Reduced River-Tunnel Alternative, involve tunnels under the Charles and Millers Rivers. The proposed tunnels will be enclosed, and, the exception of emissions which are dispersed by the ventilation system, pollutants will be contained within the structure. Periodic washing of the enclosed roadway with biodegradable detergent will flush accumulated metals and other solids into the drainage system where they will accumulate in several sumps. The solids and metals will be removed from the sumps periodically and disposed of at an appropriate location. Water will be pumped from the sumps and discharged into sanitary sewers for treatment.

There will be no long-term changes in water quality or interference with the ultimate attainment of national water quality goals. Alternative 8.1D Mod 5 and the Reduced River-Tunnel Alternative will require dredging activities within the Charles River which will create temporary, local turbidity. However, the construction area will be contained within a sheet pile earth retention system and silt curtains which will minimize turbidity as well as the amount of material necessary to be dredged.

Policy R4

"Condition construction in water bodies and contiguous land areas to minimize interference with water circulation and sediment transport and to preserve water quality and marine productivity."

There will be negligible impacts on circulation in the Charles and Millers Rivers caused by construction activities due to proposed containment of pier construction within cofferdams, and the tunnel dredge area within an underwater sheet pile earth containment system with silt curtains. A casting basin will be constructed on the north bank of the Charles River and will be retained by an approximately 225-foot-long cellular cofferdam wall of circular cells. The basin will be constructed in the dry and the floor of the basin will consist of crushed stone. There will be no long-term adverse impacts on marine productivity from construction.

Policy R5

"Ensure that dredging and disposal of dredged material minimize adverse effects on water quality, physical processes, marine productivity, and public health."

There will be no substantial long-term effects on water quality, circulation, or marine productivity from project dredging and no negative public health effects.

The dredge area required for Alternative 8.1D Mod 5 and the Reduced River-Tunnel Alternative will be confined within a sheet pile earth retention system, thereby minimizing turbidity. There may be minor temporary increases in suspended solids in the immediate area adjacent to the cofferdam walls/silt curtain. The effects of this increase are expected to be minor.

The dredging schedule will be coordinated with the Division of Marine Fisheries (DMF) in order to minimize short-term impacts on marine life. Sections 4.5 and 5.10 of the DSEIS/R provide further information pertaining to the effects of dredging on water quality and mitigation measures associated with dredging.

Policy R6

"Accommodate offshore sand and gravel mining needs in areas and ways that will not affect marine resources and navigation."

There are no offshore sand and gravel mining resources in the Project area and no offshore sand and gravel mining is proposed.

Policy R7

"Encourage the location of maritime commerce and development in segments of urban waterfronts designated as port areas. Within these areas, prevent the exclusion of maritime dependent industrial uses that require the use of lands subject to tidelands licenses."

No portion of the Project in the Area North of Causeway Street is in a Designated Port Area. Therefore, Policy R7 does not apply.

Policy R8

"For coastal dependent energy facilities, consider siting in alternative coastal locations. For non-coastal dependent energy facilities, consider siting in areas outside of the coastal zone. Weigh the environmental and safety impacts of locating proposed energy facility at alternative sites."

There are no coastal energy facilities proposed as part of the Project. Therefore, Policy R8 does not apply.

Policy R9

"Accommodate exploration, development, and production of offshore oil and gas resource while minimizing impacts on the marine environment. Evaluate indigenous or alternative sources of energy (coal, wind, solar, and tidal power) and offshore mining to minimize adverse impacts on the marine environment."

There is no energy resource development proposed as part of the Project. Therefore, Policy R9 does not apply.

Policy R10

"All developments must conform to existing applicable State and Federal requirements governing subsurface waste discharges, sources of air and water pollution, and protection of inland wetlands."

The Project will comply with State and Federal air, water, and wetlands regulations and requirements. Additional information on water quality and dredging is presented in Section 4.5.5 of the DSEIS/R. Compliance with air quality standards is discussed in Section 4.3. Compliance with wetland, waterways, and water quality requirements is discussed in Sections 5.10.1, 5.10.2 and 5.10.5 and in Appendices C (404(b)(1) and D (Wetlands/Waterways) of this DSEIS/R.

Policy R11

"Support designation of scenic rivers in the coastal zone. Support designation of Areas for Preservation or Restoration as sign-free areas."

The Charles and Millers Rivers are not proposed for designation as scenic rivers. There are no designated Areas for Preservation or Restoration that will be affected by the Project.

Policy R12

"Review proposed developments in or near designated or registered historic districts or sites to ensure that Federal, State, and private actions requiring a State permit respect their preservation intent and minimize adverse impacts."

The historic resources in the vicinity of the proposed Project and the impacts of the proposed Project on those resources are described in Sections 4.7 and 5.6 of the DSEIS/R. Issues regarding traffic management, noise, air, and vibration control, and aesthetic and joint development measures are described in the appropriate sections of the DSEIS/R. Implementation of these measures will minimize adverse impacts to the area's historic resources and maximize the beneficial impacts of the depression of the Central Artery on the visual relationship between historic resources in downtown Boston and the North End.

There are no known subsurface archaeological or historical sites within the Charles River that might be affected by the proposed Project. As requested by the Board of Underwater Archaeological Resources, MHD will provide for archaeological monitoring of exploratory borings, dredging, and other waterside construction to identify potential resources. Should such resources be found, recovery and conservation activities will be undertaken with the guidance of the Board.

Policy R13

"Review developments proposed near existing public recreation sites in order to minimize their adverse impacts."

The Project will result in an expansion of and improvement to public recreation along the Charles River. Public recreation sites in the Project area include the Paul Revere Landing Park North, which is a small area in Charlestown near the MDC dam. Implementation of the 1993 CANA temporary loop ramps permit conditions¹ will result in improvements to the Paul Revere Landing Park North. Paul Revere Landing Park South is located next to the dam on the south bank. Although it does not now function well as parkland, since it is mainly a parking lot with minimal landscaping, it will be significantly improve

¹ In 1987, the MDPW received a Chapter 91 license to construct the CANA loops in the vicinity of the Charles and Millers Rivers which required certain mitigation. Subsequently, a part of the CANA project was not completed and is being redesigned to link with the preferred alternative, once selected. In addition, in 1993 MHD secured authorizations to construct temporary CANA loop ramps with certain conditions to be implemented within the following 18 months. The mitigation measures which will be implemented within the next 2 years are assumed to be in place for the functional analysis of existing conditions.

as parkland by virtue of construction of the Project. Improvements will provide an enhanced park and public access along the Charles River. Public access along both banks of the Charles River in the North Station area will be substantially improved.

There are also existing public walkways across the Charles River at the MDC dam, locks, across the south half of the MBTA railroad bridge, along the south bank of the Charles River at the Spaulding Rehabilitation Hospital, and along the east side of the railroad bridge and trestle. However, there will be no long-term impacts on these walkways. Short-term impacts during construction will offset the walkway along the east side of the parkland trestles. In addition construction associated with the two river-tunnel alternatives will delay implementation of proposed parkland improvements at Nashua Street on the GSA sites.

2 NONREGULATORY POLICIES

Policy NR1

"Encourage and assist commercial fisheries research and development, restoration and management of fishery resources, development of extensive and intensive aquaculture, and enhancement of anadromous fisheries initiated at local, State and Federal levels."

No long-term impacts on anadromous fisheries are expected. Alternative 8.1D Mod 5 and the Reduced River-Tunnel Alternative involve temporary construction activities within the Charles River including dredging and tunnel placement. However, no adverse impacts to fisheries are expected.

Policy NR2

"Ensure that State and Federally funded public works projects proposed for location within the 100-year coastal floodplain will not exacerbate existing hazards or damage natural buffers, be reasonably safe from flood and erosion related damage, and not promote growth and development in damage prone or buffer zones, especially in undeveloped APRs."

Flood storage capacity will have no net change in the Lower Charles River Basin, as the flood elevation is controlled by the Charles River dam. New and replaced bulkheads will be designed to withstand coastal storms and erosion.

Policy NR3

"Encourage acquisition of undeveloped hazard prone areas for conservation or recreation use, and provide technical assistance for hazard area zoning and mitigation or erosion problems."

The project will greatly facilitate the recreational use of the banks of the Charles River.

Policy NR4

"Provide funding for protection from tidal flooding and erosion, emphasizing the use of non-structural measures where feasible."

The Charles and Millers Rivers are not tidal rivers. Since their elevations in normal and storm conditions are controlled by the MDC Dam, no adverse effect on tidal flooding and erosion will result from the Project.

Policy NR5

"Encourage, through technical assistance and review of publicly funded development, compatibility of proposed development with local community character and scenic resources."

Extensive community involvement in the discussions about the postconstruction use of areas within the Project alignment is ongoing and will continue. The Project will create physical and visual connections to the Charles River.

Policy NR6

"Promote the widest possible public benefit from channel dredging. Ensure that this dredging is consistent with marine environment policies."

There is no formally designated navigational channel in the Charles River. However, the Charles River is navigable and Alternative 8.1D Mod 5 and the Reduced River-Tunnel Alternative require dredging of the river during construction of a river tunnel. The top of the tunnel in both alternatives will be below the existing mudline and, therefore, will not permanently interfere with navigation.

Policy NR7

"Encourage, through technical and financial assistance, expansion of water-dependent uses in Designated Ports and developed harbors, redevelopment of urban waterfronts, and expansion of visual access."

Highway access to Designated Port Areas in South Boston, East Boston, and Charlestown will be greatly enhanced by the entire Central Artery/Tunnel Project, of which the Charles River crossing is an integral part. This access improvement will support any expansion plans for water-dependent uses in the Designated Port Areas. Improved pedestrian and visual access along the waterfront and between the waterfront and other areas of the City is likely to enhance the potential for redevelopment of those areas to an extent consistent with other State and local plans and policies.

Policy NR8

"Improve access to coastal recreation facilities, and alleviate automobile traffic and parking problems through improvements in public transportation. Link existing coastal recreation sites to each other or to nearby coastal inland facilities via trails for bicyclists, hikers, and equestrians, and via rivers for boaters."

Access to Boston and travel through the City to coastal sites north and south of the City will improve as a direct result of the Project. EOTC-adopted transportation policy is aimed at implementing public transportation improvements along with the Project as part of a comprehensive multimodal scheme for improving public access to, and reducing traffic and parking congestion in Boston. Lovejoy Wharf will be rehabilitated, providing a facility for water transportation.

Implementation of walkways on both banks of the Charles River, already agreed to in the 1991 FSEIS/R will result in a linked river-oriented recreation area between the Charles River Basin upstream and Boston Harbor.

Policy NR9

"Increase capacity of existing recreation areas by facilitating multiple use and by improving management, maintenance and public support facilities. Resolve conflicting uses whenever possible through improved management rather than through exclusion of uses."

MHD will provide for the use of the Charles River by recreational boating interests during construction of the Project by accommodating the competing needs of recreational boaters and Project contractors. It is anticipated that there will be some effect to recreational use of the Harbor in the short term, but there will be no long-term effects. Additional impacts of the Project on recreational areas are discussed in connection with Policies R13 and NR8.

Policy NR10

"Provide technical assistance to developers of private recreational facilities and sites that increase public access to the shoreline."

Public access to the shoreline will be improved or maintained in all Project areas. New public access areas will be created along the Lower Charles River Basin, including extensions of pedestrian ways near Paul Revere Landing Park North.

Policy NR11

"Expand existing recreation facilities and acquire and develop new public areas for coastal recreational activities. Give highest priority to expansions for new acquisitions in regions of high need or where site availability is now limited. Ensure that both transportation access and recreational facilities are compatible with social and environmental characteristics of surrounding communities."

The general MDC parkland master plan objective of providing public access improvements to the Lower Charles River Basin will be accommodated by the Project, as appropriate, to mitigate any direct adverse impacts of the Project.

Policy NR12

"Encourage energy conservation and the use of alternative sources such as solar and wind power in order to assist in meeting the energy needs of the Commonwealth."

Improved traffic flow will reduce vehicle fuel consumption. The Project will not impede the use of solar or wind power as energy sources.

Policy NR13

"Ensure that State and Federally funded transportation and wastewater projects primarily serve existing developed areas, assigning highest priority to projects which meet the needs of urban and community development centers."

The Project serves the densely developed Boston metropolitan area, and meets a well-documented high priority need for improved traffic capacity to and through downtown Boston, to industrial waterfront areas and to Logan Airport.

Policy NR14

"Encourage the revitalization and enhancement of existing development centers in the coastal zone through technical assistance and Federal and State financial support for residential, commercial, and industrial development."

Positive economic effects on employment in construction industries and associated multiplier effects are expected. No direct financial support for residential, commercial, or industrial development is proposed as part of this Project. Improved access to the South Boston and Charlestown port areas by the entire Project is expected to foster commercial and industrial development in those areas; easier transportation to and through Boston is expected to have general economic benefits to the City and metropolitan area.

Appendix F: Permits

APPENDIX F

PERMITS

Because of the Project's location, size, and complexity, and the types of structures to be built, including those in water bodies or tidelands, the Charles River crossing will require many Federal, State, and local permits.

To assist the agencies in their pre-application reviews, the DSEIS/R and its appendices include data and information to support environmental and construction permit applications. As a permit support document, the DSEIS/R will facilitate coordination of reviews by related agencies with overlapping jurisdictions, especially in the water resources area.

In order to obtain the required permits in a timely manner, MHD will continue to work closely with relevant agencies through the design phase to determine details of the permitting process and application review. Extensive field work and impact analyses have already been conducted and will continue as result of this coordination. Concept designs have been revised and developed to minimize adverse impacts and meet applicable codes and standards. This extensive and early coordination with the appropriate jurisdictional agencies is expected to facilitate the issuance of permits approval.

The Federal, State and local permit programs are identified in the following sections. Some of these permits require public hearings prior to permit issuance. Permit applications will be based on the preferred alternative to be identified in the FSEIS/R.

1 FEDERAL AGENCIES

U.S. Army Corps of Engineers (USACE)

- Department of the Army Permit
 - Section 10, Rivers and Harbor Act of 1899 - for placement of structures and/or work in navigable waters of the U.S.
 - Section 404, Clean Water Act - for discharge of dredged or fill material in the waters of the United States
 - Section 103, Marine Protection, Research, and Sanctuaries Act of 1972 - for transportation of dredged material for ocean disposal

Permits will be required for various activities and placement of structures within USACE jurisdiction, including: proposed dredging and filling for any proposed tunnels under the Charles River; filling for structures in the Millers River; installation of bridge piers (poured concrete) for the I-93 mainline bridge over the Charles and Millers Rivers; removal and reconstruction of seawalls to construct a casting basin (if required) adjacent to the Charles River; and the disposal of dredged materials at the Massachusetts Bay Disposal Site (MBDS) in the event that an ocean disposal option is approved.

All permit applications will be evaluated by the USACE based on public interest review of the probable impacts of the proposed activity and its use. Section 404(b)(1) Guidelines compliance must be demonstrated for permit issuance. These Guidelines prohibit discharge into aquatic areas where less environmentally damaging practicable alternatives exist. Once compliance is clearly demonstrated by the applicant, the USACE can proceed with an evaluation of public interest. The USACE considers the

following criteria, among others, in evaluating an application: the need for the project; the practicability of reasonable alternatives; and the beneficial and/or detrimental effects. Applications for the transport of dredged material for ocean disposal must demonstrate that there is no economically feasible alternative to ocean disposal in order to be permitted.

U.S. Coast Guard (USCG)

- **Bridge Permit**
 - Section 9 Rivers and Harbors Act of 1899
 - General Bridge Act of 1946 - for temporary and permanent bridges
 - Oversight of Commercial Vessel Inspection, Documentation and Manning Requirements Title 416 U.S. Code and 15 CFR - issues and renews vessels, Certificates of Documentation and Certificates of Inspection for passenger and cargo operations
 - Federal Oversight of Waterpower Activities in the Harbor and Waterfront Facilities Port and Waterways Safety Act of 1972 - ensures navigation and vessel safety, protection of marine environment, and protection of life, property, and structures in, on, or adjacent to navigable water

Bridge permits are required from the USCG in connection with the Charles River crossing. The USCG Marine Safety Office in Boston has authority and responsibility for activities concerning ports and waterways safety and commercial vessel inspection, documentation, and manning. Blasting and dredging activities will be coordinated with the Marine Safety Office.

U.S. Environmental Protection Agency (EPA)

- **National Pollution Discharge Elimination System Permits (NPDES)**
Section 402, Clean Water Act - for point source discharges of pollutants into waters of the U.S.

The NPDES permits may be required for storm drainage facilities and dewatering points that would discharge into surface waters during construction. EPA also plays a special role in the administration and oversight of other programs such as the Section 404 permit under the Clean Water Act.

A Projectwide NPDES permit for construction has been issued by EPA (#MA0033928) pursuant to the Clean Water Act, 33 U.S.C. Sec. 1342, which regulates the discharges of pollutants into waters of the United States.

An NPDES permit will be required for discharge of postconstruction Project stormwater into the Charles and Millers Rivers.

Federal Aviation Administration (FAA)

- **Determination of No Hazard**
14 CFR 77, Objects Affecting Navigable Airspace - evaluation by FAA to determine whether temporary and permanent construction may affect flight procedures, air space, and electromagnetic fields

The FAA requires notice of any construction of structures or use of construction equipment that may pose potential hazards to aviation. Federal Aviation Regulations, Part 77, requires notice to FAA of structures which exceed 200 feet above ground level, structures which exceed a 100 to 1 slope within 20,000 feet

of the nearest point of the nearest runway, structures in an instrument approach area, and structures on airport property. Potential relevant facilities for the Charles River crossing may include ventilation buildings, bridges, and construction cranes. An FAA Form 7460-1, Notice of Proposed Construction or Alteration, will be required to be submitted by the construction contractors when applicable.

2 STATE AGENCIES

Executive Office of Environmental Affairs (EOEA), Massachusetts Environmental Policy Act (MEPA) Unit

- Certificates on the SEIS/R (Draft and Final)
Massachusetts Environmental Policy Act Regulations, 301 CMR 11.00

The Secretary of Environmental Affairs makes determination for both the Draft and the Final SEIS/R documents pursuant to the above regulations. Each determination will indicate whether or not the Secretary concludes that the documents adequately meet the regulations and special requirements stated in the Secretary's Certificate issued in 1986 for the SFEIR.

The following State environmental agencies are administrative units of EOEA: the Massachusetts Department of Coastal Zone Management, the Metropolitan District Commission, and Department of Environmental Protection and its divisions.

Coastal Zone Management (CZM) Office

- Coastal Zone Management Consistency Determination
Coastal Zone Management Act of 1972
Massachusetts Coastal Zone Regulations 301 CMR 10.00

Consistency reviews from the Massachusetts Office of Coastal Zone Management are required to determine if the Project meets the CZM program regulations and policies. For example, a CZM Consistency Determination concurrence is a prerequisite to Federal permits for Federal funding for activities in geographic areas subject to the CZM Regulations.

Department of Environmental Protection (DEP)

- Water Quality Certificate
Section 401, Clean Water Act and Massachusetts Division of Water Pollution Control Regulations 314 CMR 9.00 - to certify that discharges to navigable waters will not violate effluent limitation or water quality standards. This permit is required as a prerequisite to the USACE 404 permit and the State Chapter 91 license. A Projectwide certification for construction has been issued.
- Surface Water Discharge Permit, M.G.L. c. 21, S. 43
Massachusetts Surface Water Discharge Permit Regulations, 314, CMR 7.00 are required for point source discharges of pollutants to surface waters of the Commonwealth. The permit is processed in association with the NPDES permits.
- Underground Injection Control Permit
An Underground Injection Control Permit in accordance with 310 CMR 27.00 from the Division of Water Pollution Control in the Department of Environmental Protection will be required for

the injection of dewatering fluid into the groundwater if such an activity is proposed.

- A Ground Water Discharge Permit, MGL c.21, 5.43
A Ground Water Discharge Permit in accordance with 314 CMR 6.00 from the Division of Water Pollution Control in the Department of Environmental Protection will be required for any proposed discharges of groundwater resulting from construction.

Division of Waterways and Wetlands (DWW)

- Chapter 91 license M.G. L. c. 91
Division of Wetlands and Waterways Regulation 310 CMR 9.00 and Special Procedures established between the Massachusetts Highway Department and DEP pertaining to the Central Artery/Tunnel Project dated May 16, 1991.

The purpose of the Waterways License Program is to protect the public interest in tidelands, great ponds, rivers, and streams. Activities in regulated areas are subject to review by DEP. Projects which meet regulatory standards receive licenses or permits. A license will be necessary for all activities undertaken in flowed and filled tidelands. All activities in and adjacent to the Charles and Millers Rivers such as dredging and filling activities in the channel, proposed bridges, ventilation buildings, and walkways as well as surface roads, viaducts, and boat sections will require a Chapter 91 license. All activities undertaken within 100 feet of the Charles and/or Millers Rivers are also subject to review under these regulations.

- Order of Conditions
Massachusetts Wetlands Protection Act, M.G.L. c. 131 S. 40, Division of Wetlands and Waterways Regulations, 310 CMR 10.00

The Massachusetts Wetlands Protection Act implementing regulations presume that wetlands serve several important functions, and individual projects are evaluated in relation to their impacts on these functions. These include protection of public and private water supply; protection of groundwater; flood control; storm damage prevention; prevention of pollution; protection of land containing shellfish; protection of fisheries; and protection of wildlife habitat. Acceptable projects receive an "Order of Conditions" from the local municipality after a "Notice of Intent" has been submitted and a public hearing has been held.

In contrast to the Chapter 91 program, under the Wetland Protection Act, an applicant applies to the local Conservation Commission instead of DEP. For this Project, the Boston and Cambridge Conservation Commissions have jurisdiction for work within each city's municipal boundary. Actions of the Conservation Commission can be appealed to the DEP for "Superseding Orders of Conditions."

Division of Air Quality Control (DAQC)

- State Implementation Plan (SIP) Conformance Clean Air Act - to provide coordination with FHWA and EPA and ensure conformance between Project transportation control measures and the SIP

DAQC will comment on the air quality and noise impact analyses in the DSEIS/R as a reviewing agency under regulations pursuant to the Massachusetts Environmental Policy Act.

- The DAQC Department of Environmental Protection requires approval for construction or

demolition activities in accordance with 310 CMR 7.00. Air Quality Notification for all proposed building demolition and dust and odor controls will be required.

- **Air Quality Certification**

An application for Projectwide preconstruction certification for the ventilation buildings must be filed with DEP/DAQC. This certification assures that air quality criteria established by FHWA, EPA, and DEP will be maintained throughout the life of the Project.

Bureau of Waste Site Cleanup

- **Massachusetts Contingency Plan, 310 CMR 40.00**

Promulgated under Chapter 21E, Massachusetts Oil and Hazardous Material Release Prevention and Response Act

Portions of the Project activities that occur on a site contaminated with hazardous material or oil may be subject to the Massachusetts Contingency Plan, which requires DEP notification, site assessment, and remediation. Through its Soils Characterization Study, the Project has made a preliminary assessment of the potential for contaminated sites. Further assessments are being made so that any remediation activities required can be conducted in advance of general construction.

Massachusetts Water Resources Authority (MWRA)

In coordination with Boston Water and Sewer Commission (BWSC) and DEP/DWPC, the MWRA, as an operating authority, has review and approval authority over sewer relocations and connections involving their facilities. The MWRA is principally involved with relocations of or discharges directly to MWRA sewer lines. A Sewer Use/Discharge Permit will be required from MWRA for sewer connections/extensions in accordance with CMR 360 1.00 - 10.00.

Massachusetts Department of Public Safety

A Building Permit will be required for certain structures from the Massachusetts Department of Public Safety. In order to obtain that permit, plan approval must be obtained from the Boston Fire Department, the Boston Inspectional Services Department for the electrical design, and the Massachusetts Board of Plumbing Examiners and Gas-Fitters for the plumbing designs.

3 LOCAL AGENCIES

As a State agency, MHD is subject to local ordinances or permits only to the extent that the Massachusetts Legislature has specifically determined it to be appropriate in a given situation for the State to submit to local jurisdiction, as in the case of certain environmental permitting processes. MHD will coordinate with the City of Boston and the City of Cambridge to achieve consistency of plans and objectives.

Boston Water and Sewer Commission (BWSC)

- **Sewer Extension/Connection Permit**

Because the Project involves the extension and relocation of existing sewer lines, a Sewer Extension/Connection Permit may be required from DEP, MWRA, and BSWC. Relocation of existing BSWC sewers also requires a sewer extension modification permit from DWPC and approval of BSWC, unless exempt under 310 CMR 7.05. If exempt, plan approval is required by DEP.

BWSC approves sewer and drainage connections to its system in coordination with DEP/DWPC. Such connections will be made for the ventilation buildings, highway drainage system, and dewatering activities. Water and sewer relocations will occur throughout the Project alignment in cooperation with BWSC. BWSC will be notified prior to temporary discharge of dewatering fluids to its stormwater system.

Boston Fire Department

The Boston Fire Department will review and advise MHD on certain public safety aspects including water supply and emergency communication systems.

Boston Transportation Department (BTD)

The Mayor of Boston has designated BTD as the City's liaison to the Project. BTD will coordinate all matters that affect the City during construction of the Project. The City Interagency Coordination Committee, consisting of 20 City agencies, was established in April 1988 by BTD and has held regular meetings and briefings during which they have reviewed Project plans.

BTD will review all traffic management plans and required access plans for all proposed building construction projects. BTD will also review construction management plans, plans for occupying public streets for equipment, erecting fences, and blocking sidewalks. They will also assist MHD in maintaining traffic lanes for access during construction.

Boston Redevelopment Authority (BRA)

The BRA will provide review and guidance as the City's planning and development agency.

Boston Department of the Environment

This Department includes the Air Pollution Control Commission, the Conservation Commission, and the Landmarks Commission. The Boston Conservation Commission issues Orders of Condition under M.G.L. Chapter 131 Section 40, the Wetlands Protection Act (in coordination with DEP) for any alteration of wetlands area protected by the Act. The Air Pollution Control Commission will be consulted on parking space allocation and other matters related to air pollution control and noise.

Cambridge Conservation Commission

The Cambridge Conservation Commission has jurisdiction over wetlands located in Cambridge under the Massachusetts Wetlands Protection Act.

4 OTHER APPROVALS

Handicapped Access

The work under this contract is obligated to meet the handicapped access requirements as set forth in 28 CFR Part 35, the regulations promulgated for the Americans with Disabilities Act of 1990; 49 CFR Part 27, the regulations governing the Department of Transportation in matters of nondiscrimination on the basis of handicap; and the Massachusetts Executive Order 246 of 1984, an order by the Governor that calls for equal access to employment in all endeavors of State agencies. The design criteria referenced in these regulations are the Rules and Regulations of the Massachusetts Architectural Access Board, 9/28/90, and the Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities, 1991.

Additional Permits

Various additional permits, approvals, and other requirements may be sought from the City of Boston. These include special permits from BWSC for various kinds of water, sewer, and hydrant connections; a possible variance from the Boston Air Pollution Control Commission if there are any deviations from the noise or work hour regulations; and a construction management plan from BTM.

Appendix G: Wind Impacts

Appendix G

WIND IMPACTS

This appendix includes the basis for conclusions reported in the DSEIS/R regarding wind impacts of the Project structures in Scheme Z (the Proposed Action in the 1991 FSEIS/R) and the alternatives on pedestrians (Section 4.2.2(c) in the DSEIS/R), and navigation (Section 4.5.3(b) in the DSEIS/R).

1 WIND IMPACTS ON PEDESTRIANS

A literature review and a qualitative assessment were conducted to determine the effect of Project structures on the wind environment with respect to pedestrian disturbances. The areas of pedestrian traffic in the study area are on the Charles River banks, waterfront paths, North Washington Street bridge, and the Charles River dam. There are no provisions for pedestrian walkways on the mainline I-93 bridge deck.

In general, wind speeds are higher over water, because of its smooth surface relative to an urban environment which has a rougher surface due to buildings, trees, and concrete pavement that could retard wind movement. Therefore, wind speeds are higher on or near bodies of water, for example, in boats, on bridges, or along riverbanks than those observed at open inland locations.

Studies have shown that pedestrians may experience various degrees of discomfort associated with localized wind flow disturbances. Nuisance to pedestrians is associated with disturbance of clothing and hair, and irritation of the eyes. Discomfort is defined as a noticeable reduction in physical stability affecting activities such as riding a bicycle, putting on a raincoat, holding an umbrella, or writing a parking ticket (Houghton and Carruthers, 1976).

In any given structural design, various degrees of wind-induced discomfort may be expected to occur with a certain regularity. The occurrence of discomfort experienced will depend on both the physical characteristics of the designed structure and the wind climate at the location of concern. The following sections describe the criteria and methodology used to assess the potential impacts on pedestrians in the Charles River crossing area.

1.1 Assessment Criteria And Methodology

Field observations performed at the Erskine Bridge, Scotland, were used to make assessments about the potentials for wind impacts from Project bridge structures on the pedestrian environment. The assessments indicated that measured transverse wind speeds at the Erskine Bridge deck were about 10 percent higher than those of free flow at the same height (Hay, 1984). The Erskine Bridge is a cable-stayed free-span bridge with a span of 1,000 feet, 220 feet above the water level. This is a larger and taller mass than any of the bridges proposed for the Charles River crossing. However, inferences may be drawn about wind impacts from this study.

Based on the Erskine Bridge observations, discomfort levels for the Project study were developed assuming the same 10 percent increase in wind speed at the bridge deck. The discomfort levels were defined, based on wind speed range, as "Nuisance" (5 to 10 meters/second (m/s)), "Unpleasant" (10 to 20 m/s), and "Dangerous" (greater than 20 m/s) by Penwarden (1973), and Penwarden and Wise (1975).

Wind disturbance from field and wind tunnel studies has been shown to be proportional to the cross-sectional area of the flow obstruction (EPA, 1988). Therefore, only those directions transverse to the bridge span were analyzed in this study. Winds parallel to the bridge span were assumed to produce negligible disturbance to the ambient flow. The transverse directions are N, NNE, NE, ENE, E, S, SSW, SW, WSW, and W.

Five years (1985 to 1989) of combined wind data, collected at Logan Airport, located 2.25 miles east of the Charles River crossing area, were used to perform the assessment by determining the incremental percentage of discomfort levels due to the installation of these bridges. This data set is identical to that used in the air quality impact assessment for the proposed ventilation buildings associated with the Charles River crossing alternatives. The wind data summary is presented in Table G.1.

1.2 Impact Assessment

The physical characteristics of the bridges included in Scheme Z and each of the three alternatives are summarized in Table G.2. The 10 percent increase in transverse wind speed at the bridge deck was used as the criterion to describe impacts on pedestrians in the vicinity of the Charles River crossing. This increase, when evaluated relative to the Logan Airport winds (Table G.3), shows that the cumulative percentage increase in Nuisance, Unpleasant, and Dangerous level winds is very low (i.e., 3.1 percent, 1.9 percent, and less than 0.1 percent), respectively. Since the areas of pedestrian traffic within the study area are several hundred feet or more from the bridge deck, the 10 percent wind speed increase is expected to diminish at these distances. Therefore, no adverse effects on pedestrians are expected.

In addition, the bridge tower(s) associated with any of the four designs, are open structures 200 to 300 feet high, and may have potential to cause slight localized flow acceleration. Since there are no provisions for pedestrian walkways on the mainline I-93 bridge decks, pedestrian traffic under the bridge will mostly occur when park users pass between the legs of these towers. The physical dimensions of these legs are so small that their impact on park users would be negligible.

The North Washington Street bridge and the Charles River dam walkway are more than several hundred feet away from the proposed mainline bridge in any of the designs. By virtue of the separation and the localized nature of flow acceleration, as established previously, no impact on the pedestrians crossing the bridge and dam facilities would be expected.

2 WIND IMPACTS ON NAVIGATION

The effect of manmade structures on the wind environment has been studied for various obstacles, and for sets of obstacle configurations in the field as well as with wind tunnel simulations. The majority of these studies have focused on wind disturbances produced by obstacles such as tall buildings (Lawson, 1980). The results of these studies can be used to make assumptions regarding the effects of the bridge structures and transverse winds with respect to navigation in the Charles River.

As stated, field and wind tunnel studies have shown that disturbance of the wind environment near a structure is a function of the size and orientation of the structure (EPA, 1988). By their design (i.e., lattice structure as opposed to solid), bridges pose a minimal cross-sectional area to the wind and affect the wind environment in a less distinctive manner than large buildings. Navigation under long bridges may be affected by higher wind speeds due to the bridge structure and the Venturi-type effect causing air flow to accelerate between the bridge deck/piers and the water surface.

TABLE G.1

LOGAN INTERNATIONAL AIRPORT DATA 1985-1989
FREQUENCY OF WIND SPEED AND DIRECTION
 (percent)

Direction	0 - 5 m/s Comfortable	5 - 10 m/s Nuisance	10 - 20 m/s Unpleasant	> 20 m/s Dangerous	Total
N	2.7930	2.6013	0.1164	0.0000	5.5107
NNE	1.6612	1.2413	0.0593	0.0000	2.9618
NE	1.6840	2.1313	0.3309	0.0000	4.1461
ENE	1.8734	2.0194	0.1301	0.0000	4.0229
E	2.0582	2.3138	0.1620	0.0000	4.5340
ESE	2.1290	2.7063	0.1027	0.0000	4.9379
SE	2.5443	1.6407	0.0388	0.0000	4.2237
SSE	1.7753	0.5910	0.0251	0.0046	2.3959
S	2.5945	1.8141	0.0913	0.0000	4.4998
SSW	2.5055	3.7902	0.2282	0.0000	6.5238
SW	3.5688	6.2956	0.3217	0.0000	10.1862
WSW	2.8843	5.7183	0.1848	0.0000	8.7874
W	2.0400	5.2095	0.3719	0.0000	7.6214
WNW	3.1170	8.2877	0.6982	0.0000	12.1030
NW	3.0280	7.0167	0.5819	0.0000	10.6266
NNW	2.2659	3.8312	0.2031	0.0000	6.3002
TOTALS	38.5223	57.2084	3.6464	0.0046	100.0000 ¹

Source: Bechtel/Parsons Brinckerhoff

¹ rounded

TABLE G.2

CHARACTERISTICS OF THE CHARLES RIVER CROSSINGS BRIDGE DESIGNS

Characteristics	Scheme Z	Alternatives		
		8.1D Mod 5	Reduced River-Tunnel	Non-River-Tunnel
Number of bridges	Two 5- to 6-lane (LSB) and One 6-lane double-deck (MSB)	One 10-lane (LSB)	One 12-lane (LSB)	One 10-lane (LSB) and one 4-lane (MSB)
Tower height	Two 330-foot A-frame towers	Two 360-foot needle Towers	Two 310-foot diamond towers	Two 310-foot diamond towers
Width of bridge corridor (includes multiple bridges)	275 ft.	170 ft.	230 ft.	330 ft.
Length of main/back spans	NB 680 ft. main; 360 ft. back SB 650 ft. main; 340 ft. back	720 ft. main; 440 ft. back	275 ft. main; 370 ft. back (two towers)	275 ft. main; 370 ft. back (two towers)
Length of medium-span bridges	330 ft.	N/A	N/A	330 ft.
Number of piers	11	2	4	4
Pier dimensions	10 ft. x 10 ft. to 30 ft. x 30 ft.	25 ft.x 20 ft.	25 ft.x 20 ft. (2) N-side 25 ft.x 10 ft. (2) S-side	25 ft.x 20 ft. (2) N-side 25 ft.x 10 ft. (2) S-side

Notes: NB - northbound
 SB - southbound
 LSB - long-span bridge
 MSB - medium-span bridge

All bridge structures maintain vertical clearance of 23 feet above the recreational lock and 30 feet above the commercial lock.

Table G.3

**MAXIMUM CROSSWIND INCREASE AT BRIDGE DECK
(percent)**

Scheme Z

Crosswind Directions	5 - 10 m/s Nuisance	10 - 20 m/s Unpleasant	> 20 m/s Dangerous	Total
N	0.3651	0.1346	0.0000	0.4997
NNE	0.1643	0.0730	0.0023	0.2396
NE	0.0547	0.2464	0.0000	0.3011
ENE	0.1849	0.1528	0.0000	0.3377
E	0.3811	0.0844	0.0023	0.4678
S	0.4244	0.0639	0.0000	0.4883
SSW	0.2715	0.2190	0.0023	0.4928
SW	0.5796	0.3606	0.0000	0.9402
WSW	0.5112	0.2373	0.0000	0.7485
W	0.1688	0.3423	0.0000	0.5111
TOTALS	3.1056	1.9143	0.0069	5.0268

Source: Bechtel/Parsons Brinckerhoff

As stated in Section 1 of this Appendix, field observations performed at the Erskine Bridge, Scotland, indicated that measured transverse wind speeds at the bridge deck were about 10 percent higher than those of free flow at the same height (Hay, 1984). Based on wind tunnel tests on flow patterns around solid structures, the following principles apply:

- Building wakes usually extend downwind to about five times the building height or width, whichever is less.
- The deflection of flow around a building usually occurs within half of the building height or width (EPA, 1988).
- Less distortion of flow patterns is generally observed for flow passing lattice structures. Since the bridges in all designs are open-lattice structures, the disturbance flow is expected to return to normal not far down (i.e., less than several widths of the bridge) or below the bridge (i.e., less than the depth of the bridge deck). To be conservative, a 10 percent wind speed increase throughout the whole layer of air flow under the bridge deck was assumed for this study.

Vessels navigating the Lower Charles River Basin are unlikely to be using sails, which would diminish the available cross-sectional area perpendicular to the wind. Therefore, boats passing beneath the proposed bridges will be subjected to minimal influence of the assumed 10 percent increase wind speed. Since boats will likely be motor power driven without sails, the 10 percent increase in wind speed will have minor impact on navigation in this section of the Charles River.

The height above water of the bridge span, width and elevation of the bridge deck, and the number, size, and spacing of the bridge piers are also of concern in addressing wind impacts to navigation under the bridge.

Characteristics of each alternative and of Scheme Z are summarized in Table G.2. Based on the conceptual engineering design, the bridge span clearance for all four designs ranges from 23 feet to 65 feet above the water. For these clearances, the formation of a Venturi-type effect under the bridge is expected to be minimal. However, as the width of a bridge increases, so does flow channeling. Since each pier represents an obstacle to the channeled air flow under a bridge, a higher number of piers will also increase turbulence in the air flow below the bridge span.

The degree of wind disturbance due to the bridge piers is a function of the pier size, number of piers, and the spacing between the piers. As shown in Table G.2, the size of each individual pier in all designs is much smaller than the overall bridge structure, and can be considered as a small structure. They are also widely spaced toward each end of the bridge span in the three alternatives. Therefore, their influence on the wind environment is expected to be localized, i.e., within a distance less than their width (20 feet). In addition, a pier fendering system will be placed between the piers and the navigational channel, minimizing the localized wind impacts.

There are three bridges in Scheme Z with different elevation profiles which create a larger effective cross-sectional area than the three alternatives (see Table G.2). Therefore, out of these four designs, the greatest increase in turbulence is expected to result from Scheme Z due to its relatively wide combined bridge deck, double-deck bridge, and large number of piers.

Summary. Navigation on the Charles River is not expected to be adversely affected by any of the Charles River Crossing design schemes due to wind. In assessing potential effects of wind on navigation, the relevant structural dimensions of each river crossing design are the width and elevation of the bridge

deck, the height above water of the bridge span, and the number, size, and spacing of the bridge piers. Since Scheme Z includes a double-deck bridge, a relatively wide deck for the mainline bridges, and a larger number of piers than the three alternatives, the greatest increase in flow disturbance is expected to result from Scheme Z. However, significant flow acceleration under the proposed bridges is not expected, and flow disturbance resulting from bridge piers is localized under all four designs.

REFERENCES

- 1 EPA *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources*. EPA-450/4-88-010, August, 1988.
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